PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

SEMI-MONTHLY

VOL. XVII CHICAGO, MAY 1, 1913 No. 9

MODERN INDUSTRIAL POWER PLANT

Direct-Driven Alternating-Current Generating Units Supplying Powers to Motor-Driven Machinery; Combination Soft Coal and Refuse Fuel; Method of Collecting and Delivering Sawdust and Shavings to the Boilers

BUZ-Z-Z-Z-Z, AND THEN SOME b-r-r-r-r-r, and then some more. These noises clearly indicated the presence, not far distant, of a large number of wood working machines, and sure enough there were, as the Practical Engineer scribe was nearing the furniture factory of Fenske Bros., in Chicago, and the power plant that furnishes the power to drive all these machines was the particular spot where my interest was centered.

Say fellows, when you were resting comfortably on the best parlor sofa, courting your girl, did you ever think of the processes necessary to turn a lot of rough planks, as they are unloaded from the car, into that "comfy" old sofa, and think also of the kilowatts necessary to produce the power needed in the various processes? Sure you didn't, you are just as I was

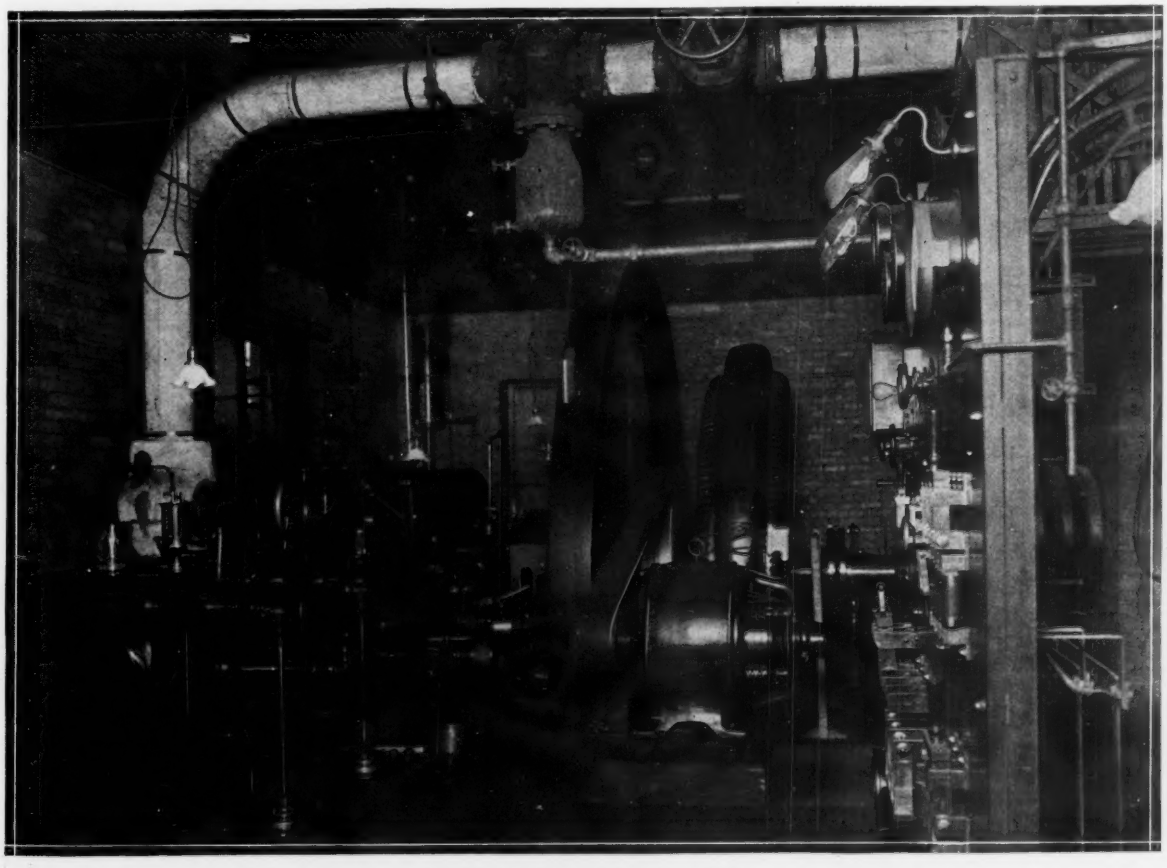


FIG. 5. LARGE GENERATING UNIT

when young, you thought of nothing but the girl, and you didn't care a rap if it took all of the kilowatts in creation to make that sofa. Well, well, I am commencing to wander away from the subject.

On arriving at the works, like the call of the wild, that something-indescribable-sort-of-feeling drew me toward the engine room, or rather first to the boiler room where the entrance to the power plant is located. Upon stepping inside the door I came very near taking an impromptu ride in a horseless carriage, which consisted of a wheelbarrow with a son of old Italy at the helm. This was my introduction to Tony who became quite communicative, and he spilled an ear full of information about himself while I was waiting for the chief to make a trip around the shops.

General Details

THE old engine belted to a jack-shaft and the jack-shaft belted to a line shaft and the line shaft to something else, making one think of that old ditty we used to sing when kids: "The bird in the nest, the nest on a twig, the twig on a limb, the limb on a tree, the tree in the ground and the green grass growing all around round round," is practically a thing of the past in industrial plants. Now we see modern generating units, direct driven by engines or turbines, which supply current to motors geared to the machines they drive.

Long lines of shafting and heavy belting are conspicuous by their absence, and the general arrangement of machinery, where electric drive is used, can be made to facilitate the logical sequence of manufacturing operations without rehandling material over and over again.

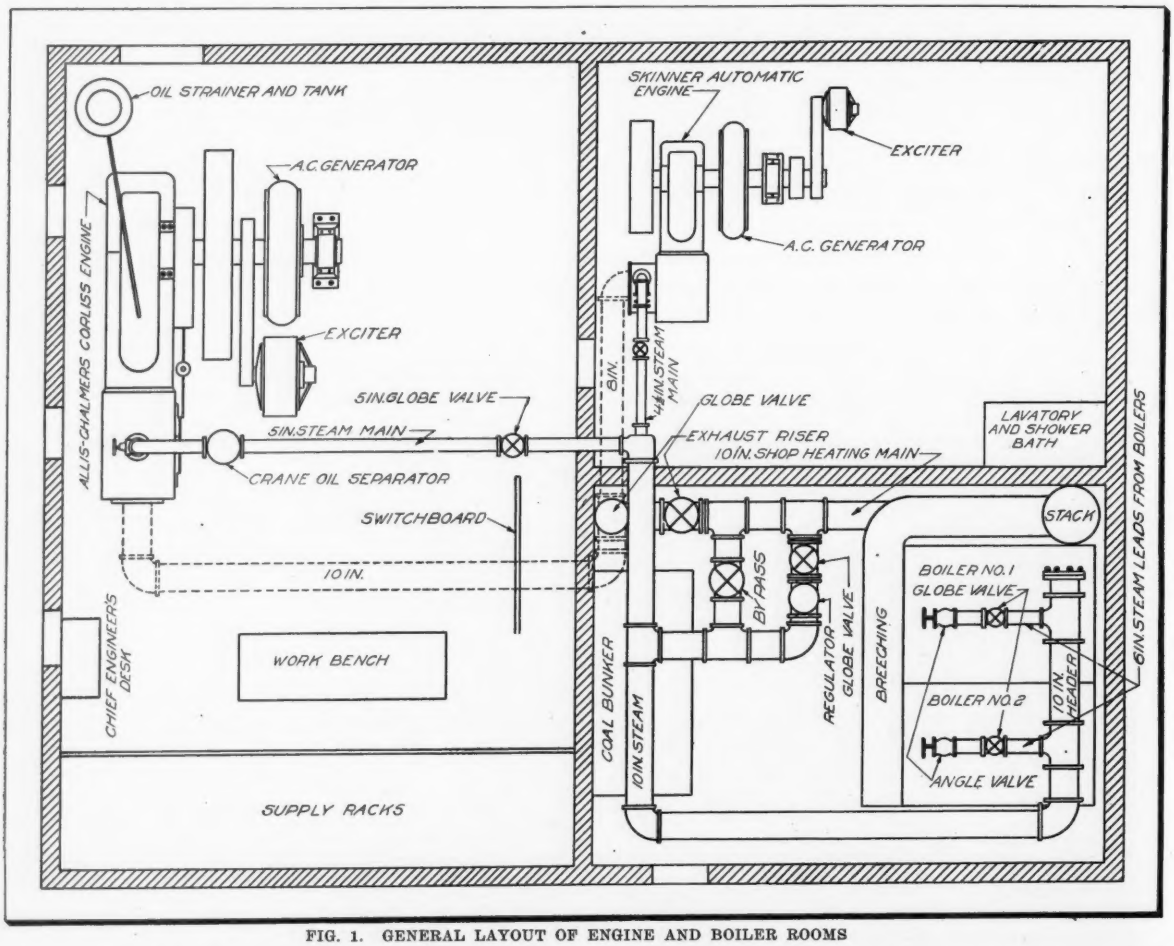


FIG. 1. GENERAL LAYOUT OF ENGINE AND BOILER ROOMS

Tony is the "Knight" of the coal pile, in a double sense of the word; his countenance contained enough coal dust to give a life size imitation of night, but further the coal pile was his domain, he was the ruler and begrudgingly carted the coal, little by little, to the convenient reach of the fireman's scoup.

"Ima sick, sicka in my stomach, canna no eat, feela rotten, no ambish. Wenta to see the doc last night, he tella me I can holda the banan on my stomach, I holda 5 on tilla my hand goesa to sleep, but don'ta do no good." At this stage of the game the chief appeared on the scene and I was relieved from further tales of woe, and believe me we all have troubles enough of our own without borrowing them from others.

To stand by a buzz planer and see it bite off great chips from a big plank, like some giant animal, then to realize that the power to drive this seemingly human monster comes over a few small wires, gives one an almost uncanny feeling. In the Fenske plant all of the woodworking machinery is driven by electric motors supplied with power from a modern plant.

Direct-driven alternating-current generators of the latest type, supply current to some 23 induction motors and hundreds of incandescent lamps. The power plant occupies 3 sections on the ground floor

of the main building, consisting of a boiler room, containing the boilers, pumps, feed-water-heater and other auxiliaries; the old engine room and the new engine room all connected by fire-proof iron doors. The new engine room contains the large generating units, switchboard, stock racks and work bench, while the old engine room houses a second generating set and last but not least a fully equipped shower bath with running hot and cold water. The chief showed me this part of the equipment with some pride, as he is a firm believer in the saying that "cleanliness is akin to Godliness" and on a hot night after a hard day's work thinks cleanliness is a close second sure enough.

Boilers and Boiler Room Equipment

BOILER equipment consists of one Murray Iron Works 18 ft. by 72-in. return-tubular and one Frost Mfg. Co., return-tubular boiler of the same dimensions. Both boilers are equipped with grates with dimensions of 5½ by 6 ft., making 33 sq. ft. of grate surface. Each boiler contains 70 4-in. tubes, has a 7/16-in. shell and triple riveted butt joints; breeching from both boilers terminates in a common stack which furnishes natural draft.

Bituminous coal and refuse from the wood-working shops are used for fuel; the coal is delivered on a railroad siding and is dumped into a bunker at one side of the boiler room. Located in the wood working shop is an 8 ft. Oneida motor-driven exhaust fan connected to a system of exhaust piping leading to the various machines. The sawdust and shavings thus collected are forced through a feed pipe extending across an alleyway to the ceiling of the boiler room to a header where 2 branch pipes lead to the boiler furnaces entering above the fire doors as shown in Fig. 3; no cyclone is used. An air vent is located near the junction of the main feed pipe and the branches leading to the boilers as the supply of air furnished by the fan is too great for normal combustion.

Steam pressure at the boilers is maintained at from 100 to 110 lb., although a pressure of 125 lb. is permitted by the boiler inspector. Boiler steam outlets are 6 in. in diameter and connect to a 10-in. header; the auxiliary fittings including gages, safety valves, steam and water valves were all furnished by the Crane Company.

As will be seen from Figs. 1 and 2, which show the general layout of the plant and the boiler room piping respectively, a 10-in. exhaust pipe cares for the 2 engines and extends to the roof through the boiler room; through the engine room it is concealed in a trench beneath the floor. Near the roof is located a back-pressure valve and beneath it is a 10-in. branch pipe for shop heating; provision is also made for supplying the heating system with live steam.

The arrangement for feeding live steam into the heating system is shown in Fig. 1. A short dead end branch extends at right angles with the main steam line, parallel to and a short distance from the exhaust steam heating main, and is connected to the exhaust heating main through a steam regulator, which reduces the steam pressure to 4 lb., and a globe valve; a bypass controlled by a globe valve, also con-

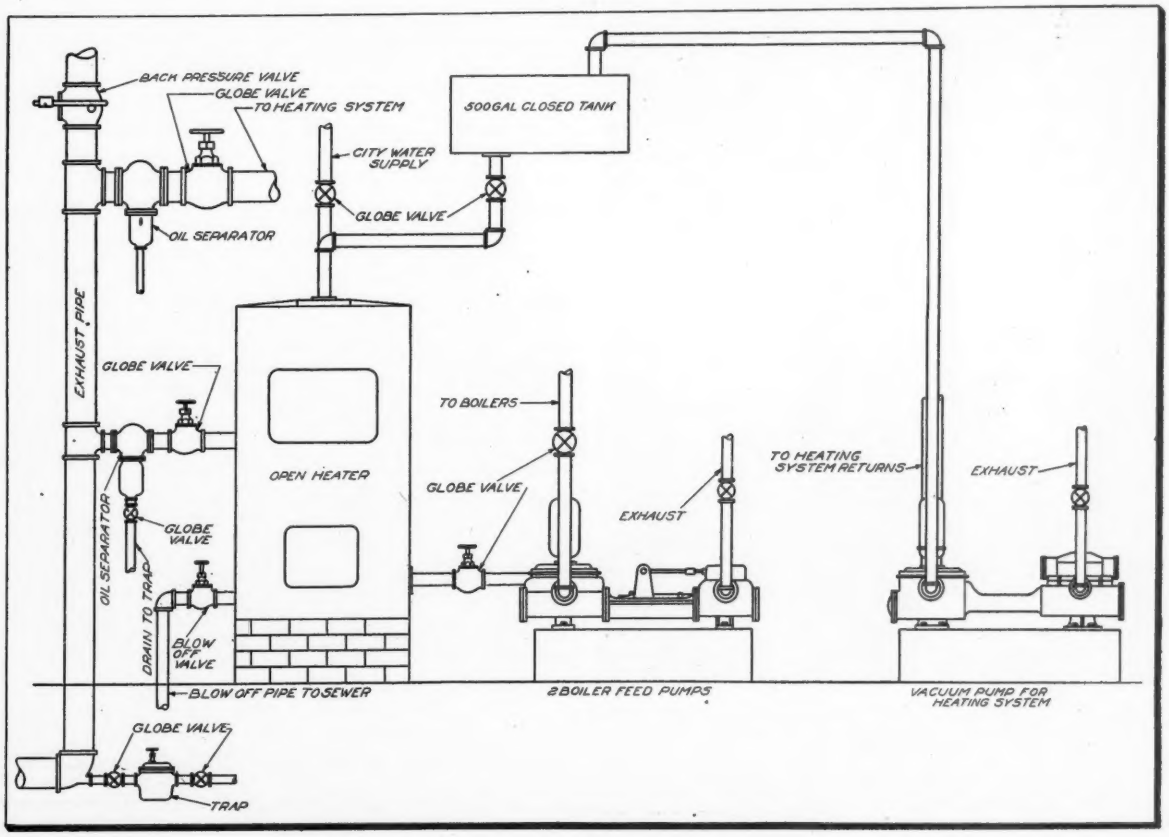


FIG. 2. DIAGRAM OF HEATER AND PUMP CONNECTIONS

nects the branch to the heating main for emergency use in case the regulator for any reason becomes inoperative.

Feed Water; Blowoff Connections

CITY water is used for the boilers and is heated by a Colles open heater connected by a short 5-in. branch with the exhaust riser; a 5-in. Crane oil separator and a 5-in. globe valve are connected in this branch. The water from the heater is pumped to the boilers by one Dean and one Cannon & Hughes duplex pump with dimensions of 6 by 4 by 6 in.; one pump is held in reserve and no injectors are used.

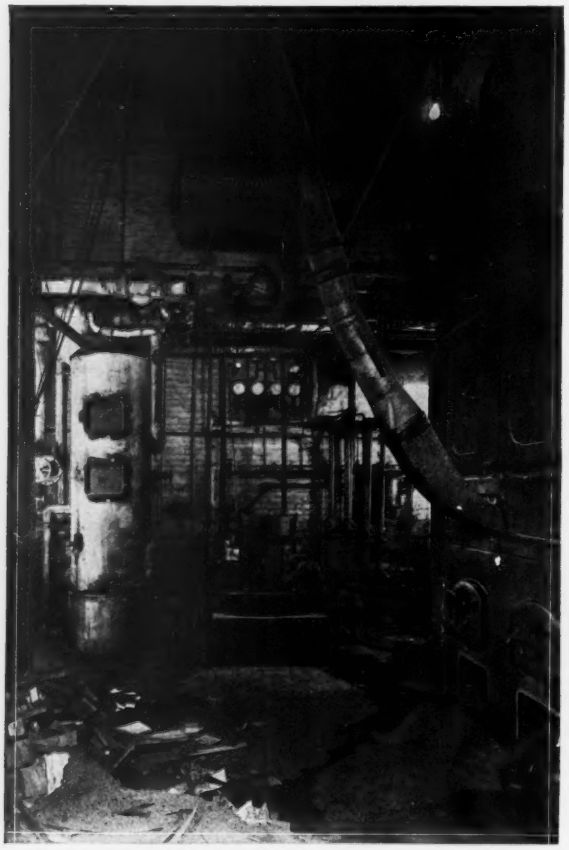


FIG. 3. FRONT OF BOILER, SHOWING REFUSE FEED PIPE, FEED-WATER HEATER, BOILER FEED-WATER PUMPS AND VACUUM PUMP

Between the junction of the engine exhaust pipes with the main pipe and the heater is located a drain pipe connected to a trap which drains to the sewer. A vacuum system of heating is used, all radiators being equipped with Dunham return valves. The heating returns are pumped by a Marsh 6 by 10 by 10-in. simplex vacuum pump to a 500-gal. closed tank located approximately 6 ft. above the heater, and empties into the heater by gravity; in addition there is a cold water pump and tank for building supply. The heater and pumps are shown in Fig. 3.

Figure 4 shows the arrangement of blowoff, feed water, and header drain piping; a blind flange covers the end of the blowoff pipe which can be readily removed to facilitate cleaning the latter. The boiler feed water and the condensate from the header enters through the blowoff pipe. The figure shows plainly the arrangement of valves and piping.

Engine Room Equipment

THERE are 2 generating units; the large unit consists of a 16 by 30-in. Allis-Chalmers new type noncondensing single-cylinder Corliss engine, direct connected to a 3-phase 60-cycle revolving field alternator of the same make with a rating of 420 amperes at 220 volts shown in Fig. 5. The exciter which is belted to a pulley on the engine shaft located between the flywheel and generator, has a rating of 112.5 amperes at 110 volts. The speed of the engine and generator is 120 r.p.m. and that of the exciter 625 r. p. m.

One feature of the engine is the special high-speed single tension spring governor with all moving parts enclosed in a stationary casing. The oiling arrangement of the engine is the Nugent automatic system; the oil is pumped from a drain tank beneath the floor

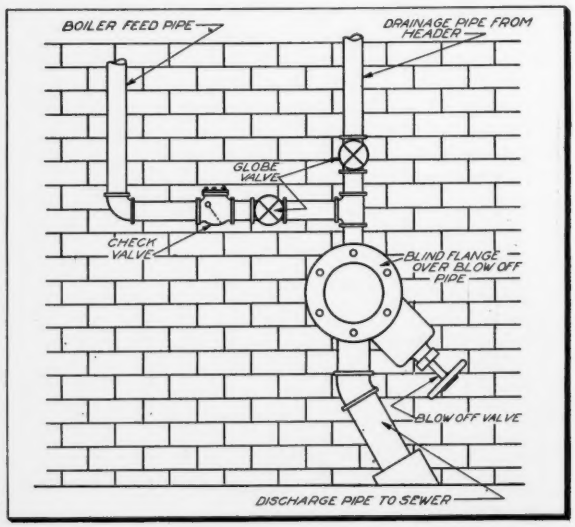


FIG. 4. BLOWOFF AND FEED-WATER CONNECTIONS

which receives all drippings from the engine, to a filter and tank located above the highest lubricated part of the engine, from which the oil flows back by gravity to the bearings. The steam main for this engine is 5 in. in diameter in which a 5-in. Crane oil separator is connected; the exhaust pipe is 10 in. in diameter.

The small generating unit shown in Fig. 6, consists of a Skinner 9 by 15 simple noncondensing engine equipped with the Skinner automatic oiling system, direct connected to a Western Electric 3-phase 60-cycle revolving field alternator, rated at 180 amperes and 220 volts, operating at 276 r.p.m. The 120-volt exciter is belted to a pulley on the extended generator shaft. The steam main is 4½ in. in diameter and in which is connected a Crane oil separator. Both generating units are arranged for parallel operation, although the large unit is used for the day load and the small unit for night load, to secure continuity of service it is necessary to throw one generator into service before cutting out the other.

A Bit of Conversation

AT this time I had to wait for a long exposure for a picture of one of the generating units so thought I'd sit down for a bit of conversation with the chief and smoke a pipe of tobacco. "Well, chief, I see you are quite a reader, judging from the number of maga-

zines and books I see on your desk." "Well, no, I can't say that I am," he replied. "I get some chance during odd hours in the daytime to read and study but am now confining myself to one engineering paper. It is frequently 9 o'clock before I get home at night and I feel as though I had enough engines, motors and generators in my head, and am glad to get away from the subject for a few hours. During the noon hour when not interrupted I do some regular studying, but unfortunately for me, there are many days when some minor repairs have to be made during the dinner time shut-down. It was only yesterday morning I discovered a loose connection on one of the motors, one of the leads was loose in the connecting lug and it had to be soldered as soon as the 12 o'clock whistle blew.

"My idea of study is to follow some definite outline and give some time, no matter how little each day, to the subject. It is surprising how much one will accomplish in a year. It requires bulldog tenacity, yes I may say stubbornness, which makes me think of an old farmer back in the mountains of York state. It was one of those bitter winter days so often experienced in that region when most drivers run along beside their sleighs vigorously slapping their arms, that a fellow noticed the old man always stuck to his seat, and asked why he did not get out and run a bit. The reply came in a blunt manner; 'Huh! I'll sit and

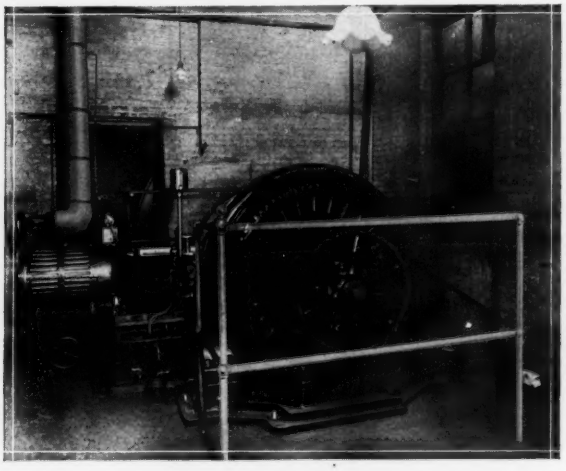


FIG. 6. SMALL GENERATING UNIT

freeze to death like a man and not run behind like a blamed dog,' and there you are, just make up your mind to sit and study like a man and not chase around behind the sleigh of progress for the rest of your natural life."

"You are right chief," I replied, "many a poor coal passer like our friend Tony out in the boiler room might be in your position today if he had your spirit."

Switchboard and Connections

THE switchboard consists of 3 black enameled slate panels, 2 generator and one feeder panels. The panel for the large generator is equipped with a Wagner alternating-current voltmeter and ammeter; synchronizing plug and lamp; voltmeter switch for connecting the voltmeter to the different phases, exciter and generator field rheostats. Main switch; a Westinghouse polyphase integrating wattmeter, and a Tirrill regulator. The small generator panel contains an International ammeter and voltmeter, generator and exciter, field rheostats, voltmeter switches and main switch. The feeder panel contains 2 feeder switches and an Industrial Instrument Co.'s circular chart steam recorder.

Figure 7 shows the switchboard, generator and exciter connections; the synchronizing and instrument connections have been omitted for the sake of simplifying the diagram. The special feature of the switchboard is the use of a Tirrill regulator in connection with the large generating unit; the regulator connections are shown in the upper left-hand corner of the diagram. A solenoid A is connected through the shunt transformer B across the circuit to be regulated; the core of the solenoid is attached by a flexible connection to the lever C on the other end of which is a balancing weight E, and a contact point D.

A second solenoid F is connected across the exciter terminals; this solenoid is connected flexibly to the lever G on which is a contact that engages with contact D on lever C. Through the engagement of

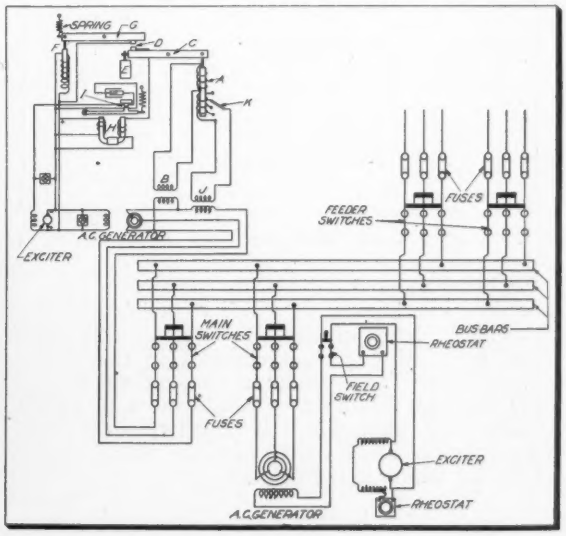


FIG. 7. SWITCHBOARD AND GENERATOR CONNECTION DIAGRAM

these contacts one of the 2 circuits of a differentially wound magnet H is completed, which allows the exciter field rheostat to be short circuited by the contacts I. A condenser is connected across the contacts to prevent arcing when the circuit is broken at the contact points, the condenser receiving the full voltage at the contacts at the time of break which charges it, when the contacts again engage the condenser is discharged.

Levers of the 2 solenoids, one connected across the circuit to be regulated and the other across the exciter terminals, form a floating contact when the circuit voltage is low and is broken when the voltage tends to rise. By this arrangement the exciter voltage may be varied from about 70 volts to its maximum voltage.

Over compounding is accomplished by connecting the series transformer secondary winding J to the turns K on the alternating-current solenoid so as to oppose the action of the shunt coil. As the load comes on the voltage must be increased to give sufficient pull on the core to operate the floating contact.

As I shook hands with the chief and said goodby, I felt well repaid for my visit and only wished that more men in his profession took the same attitude in regard to study and advancement.

LUMBER DRYING KILNS--I

Methods Employed, Time Required, Precautions to Avoid Checking and Honeycombing

By Charles L. Hubbard

THE object of the following article is to give the manufacturer or plant foreman a clear understanding of the principles which enter into the kiln drying of lumber of different kinds. While the subject is presented in a simple manner, the writer has endeavored to make it sufficiently technical to be of practical value in deciding upon the best type of apparatus to use under different conditions, and also in guarding against devices offered by dealers which may not meet the requirements of the particular case at hand.

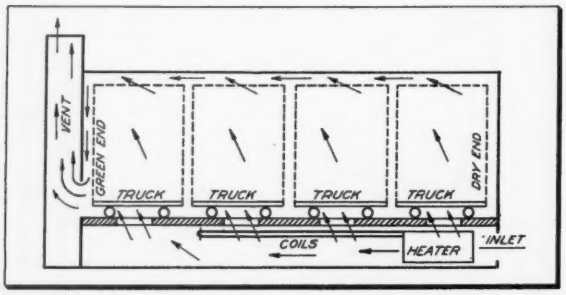


FIG. 1. MOIST AIR OR RADIATOR KILN ARRANGEMENT IN VERTICAL SECTION

The data has been gathered from reliable sources, such as the bulletins of the U. S. Department of Agriculture, practical engineers engaged in this line of work, and also from different publications treating on the drying of lumber. While there is nothing especially new presented, it is hoped that the article in its condensed form will be of some practical value to those for whom it is intended.

Evaporation

BEFORE referring specifically to the drying of lumber it may be well to consider briefly the action of evaporation, or drying, in a general way, without reference to any particular substance. The 2 requisites in drying are heat and the removal of the vapor as fast as it is formed. In order to change water into vapor under given conditions it is necessary to provide a definite amount of heat, whatever the process.

To change a pound of water into vapor at a temperature of 60 deg. F. requires 1.072 B.t.u., and the vapor thus formed weighs 0.82 lb. per 1000 cu. ft., and produces an absolute pressure of ¼ lb. per sq. in. if confined in a closed vessel.

To evaporate a pound of water at 212 deg. requires only 966 B. t. u., but produces a pressure of 14.7 lb. per sq. in., which is just equal to that of the atmosphere; also vapor at this pressure is heavier and 1000 cu. ft. weigh 40 lb. The process of evaporation is not affected by the presence of air; if the closed chamber or vessel in which evaporation takes place is filled with air, the formation of water vapor will be the same as if no air were present. That is, in the latter case, with a temperature of 212 deg., evaporation will continue until each 1000 cu. ft. of space contains 40 lb. of vapor, at which point it will cease unless the vapor be removed. Air which may be present under these conditions is said to be saturated.

Although it is seen from the above that air takes no part in the process of evaporation, it is necessary as an agent for the removal of the vapor after it is formed. This is especially important when evaporation takes place at temperatures below 212 deg., because the vapor formed under these conditions exerts a pressure less than that of the atmosphere and cannot readily rise through it. Therefore, when drying is carried on around a temperature of 212 deg., a forced circulation of air is of great advantage. The movement of the air not only increases the rate of drying by removing the vapor as it is formed, but also hastens evaporation by furnishing more heat to the drying object.

Principles Involved in Kiln Drying Lumber

HAVING taken up the process of evaporation, or drying, in a general way, let us now consider some of the conditions to be met and overcome in the artificial seasoning of lumber.

Drying of lumber differs from the process as applied to many other substances because special precautions are necessary to prevent distortion of shape and loss of strength. In the case of chemicals or fabrics, for example, it is only necessary to vaporize the moisture and provide a sufficient circulation of air to carry it away, which is a comparatively simple matter. The art of drying lumber is one which requires a good deal of experience because conditions and requirements vary so widely, not only with different kinds of wood, but also with the same kinds, which are to be used for different purposes. The moisture to be removed from green lumber is not pure water, but contains various substances in solution and is called the sap.

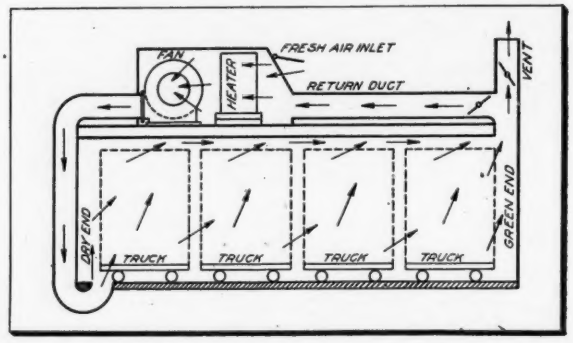


FIG. 2. VERTICAL DIAGRAM SECTION OF HOT BLAST OR FAN KILN

In deciduous trees such as maple, oak, chestnut, birch, walnut, etc., the principal element contained in the sap is of a sugary nature, while conifers, such as cedars, pines, junipers, spruces, cypresses, etc., contain resin. Both classes of trees contain albumen in addition to the substances mentioned above.

The way in which the moisture is distributed in the substance of the wood is not only of interest, but has an important bearing upon the method of removing it, and also upon the physical condition of the wood as affected by the process. Part of the moisture is held by the material of the cell walls themselves, while the remainder occupies the pores. In the pro-

cess of drying, the latter, or free portion, is first driven out, after which the cell walls give up their own moisture.

The resin contained in conifers is not driven out by the application of heat, but is caused to harden instead; but being made up largely of carbon the effect is beneficial rather than injurious. One difficulty experienced in drying the wood of deciduous trees is the strong attraction of the substances contained in the sap for water. This not only retards the process in the first place, but causes the lumber to reabsorb moisture from the atmosphere after it has been dried. This condition, however, may be much modified by subjecting the lumber to a high temperature in the process of drying, which is done in some cases by the use of steam.

The artificial or mechanical process of drying is more thorough than the natural. Air-dried lumber, under ordinary atmospheric conditions, retains from 10 to 20 per cent of moisture, while that dried by artificial means may have as low as 5 per cent when it comes from the kiln, and at the same time its power of re-absorption is less. In order to obtain satisfactory results, drying must start at the heart of the wood and progress outward, provision being made for removing the moisture as soon as it reaches the surface.

Time Required

ONE of the most important factors in the process of drying is that of time, and this depends largely upon the kind of wood, the process used, and various local conditions. In some of the largest and most up-to-date plants, hardwood flooring is dried in from 3 to 5 days, while as a rule, 1-in. white oak, which may be taken as a standard, requires, under ordinary conditions, from 1 to 2 weeks, and sometimes twice that. The time required not only varies with the species, but also with the use for which the lumber is intended. For example, plain oak requires about ⅔ as long as quarter-sawed oak, and mahogany practically the same as plain oak. Again, taking plain oak as a standard, the time of drying for different woods may be taken approximately as follows: Birch, ½ to ⅔; poplar and basswood, 1/5 to ⅔; maple, 1/5 to ¼; ash about the same as oak, or slightly less.

Cost of Drying

COST varies more widely that the length of time, as so much depends upon the size of the plant, its equipment, and the skill of those in charge. Estimates are given, running from 75 cents per thousand feet in the larger plants, to $5 in the smaller and less efficient ones.

Precautions Necessary in Kiln Drying

GREAT care is required in the seasoning and preparation of lumber, else such defects as twisting, warping, checking, casehardening, and honeycombing are likely to occur. Twisting and warping are even more apt to occur in air-drying than in kiln-drying, and great care should be taken to reduce this as much as possible by proper piling, which among other things calls for cross-sticks at the very ends of the pile. Checking is caused by too rapid drying, and should be guarded against as much as possible when mechanical means are used.

Casehardening is also caused in the same way, unless proper means are taken to prevent it. This is a condition where the surface becomes dry and impervious to the passage of water, while the interior is still moist. The result of this is the formation of internal checks called honeycombing.

From what has previously been said regarding the principle of evaporation, it is evident that the first step in the drying of lumber is to raise the temperature of both the wood and the water which it contains to the degree at which drying is to take place; and the next, to provide a sufficient circulation of air to carry away the vapor thus liberated.

One important point to be considered, however, in this connection, is that of surface drying, while the interior still contains a considerable amount of moisture. This condition occurs when the wood is slowly heated and the vapor removed as fast as formed. To guard against this, it is necessary to retain the moisture first evaporated about the wood, while the continued heat penetrates to the internal moisture. This condition also applies to stock which has been partially air-dried, and the interior may contain a considerable amount of moisture while the surface has the appearance of being well seasoned. Steam is frequently used to wet and heat the wood before the process of drying actually begins, a special chamber being provided for this purpose. While increasing the amount of moisture to be evaporated, it also shortens the time of drying by quickly raising the temperature to the evaporating or drying point. After the lumber has been put in this condition, the drying process may be forced by mechanical air circulation, at first keeping the air saturated to prevent surface drying, and finishing by admitting hot unsaturated air, replacing it constantly as it becomes saturated.

Plant Requirements

ESSENTIALS of a satisfactory kiln may be enumerated as follows: A heater, or system of heaters, of sufficient capacity to maintain the necessary temperature at all times; accurate control of the temperature and humidity in the drying chamber; also, easily operated devices for varying the circulation as may be necessary, both between the kiln and the outer atmosphere, and between the 2 ends of the kiln.

Types of Kilns

TWO types of kilns are in general use, known as the "moist-air" and "hot-blast" kilns, or better, "radiator" and "fan" kilns. A diagram of the first of these illustrating its general construction and the principle upon which it operates is shown in Fig. 1. The main heater, or radiator, is shown at the right beneath the floor of the drying chamber. From this a shallow coil from 1 to 4 pipes deep is carried about ⅔ the length of the kiln as shown. Trucks, with their loads of lumber, indicated in dotted lines, nearly fill the main chamber, spaces being allowed only for the free circulation of air around them. The general direction of the air currents is clearly indicated by the arrows and needs no description.

A kiln of the fan or blower type is illustrated in Fig. 2. In this arrangement the heater is placed outside the kiln and the hot air forced in by means of a fan as indicated by the arrows.

Methods of Drying

THE two general methods employed in the drying of lumber are known as the "progressive" and "charge" systems. The first of these is especially adapted to cases where the wood to be dried is of fairly even thickness and quality, and where the drying is done continuously and in large amounts. The kilns employed for this purpose ordinarily run from 50 to 150 ft. in length by 10 to 30 ft. in width, with a height of 6 to 8 ft. The temperature and humidity are under

the control of the operator, and are so distributed that the trucks of lumber in passing from the green to the dry end of the kiln are first moistened, then heated, and finally dried; the different stages in the process being carried on simultaneously in different parts of the kiln.

In the moist air or radiator system, there is but little circulation, and the temperature and humidity are nearly the same throughout the entire chamber. Under these conditions the lumber must be so hot, when removed from the kiln, that the residual moisture will dry out after it is placed in the open air.

The required degree of humidity in radiator kilns is usually obtained by a regulation of the circulation and temperature by means of dampers and valves.

The necessary moisture is furnished by the green lumber. In case of the fan system, circulation is lengthwise of the kiln, the moisture from the dry end being carried back to the green end and deposited upon the lumber. Additional moisture may be obtained by means of a return duct, as indicated in Fig. 2, or by admitting wet steam, either into the air space at the fan or in direct contact with the lumber. The temperature difference, in cases of this kind, commonly varies from 20 to 40 deg. at the 2 ends of the kiln. In general, experience shows the moist-air system to be better adapted to woods heavier than pine and poplar, and recent developments in kiln drying have been more especially along that line.

The charge system is widely used where smaller quantities of lumber are dried at one time. Kilns of this type are usually square in form and the lumber placed on trucks or piled on the floor and the entire charge dried before fresh material is introduced. Drying in any case may be either continuous or intermittent, but the former is much to be preferred when possible.

TEST OF ELECTRIC CONDUIT

Bursting Strength Under Pressure to Determine Its Value for Irrigation Lines

By S. M. Kane

RECENTLY, at the Washington State University, a hydrostatic test was made for a commercial house, on its 4-in. electric conduit.

The object was to ascertain whether the conduit would stand sufficient pressure for irrigating purposes; from 40 to 60 lb. per square inch being judged sufficient to make it suitable for this purpose.

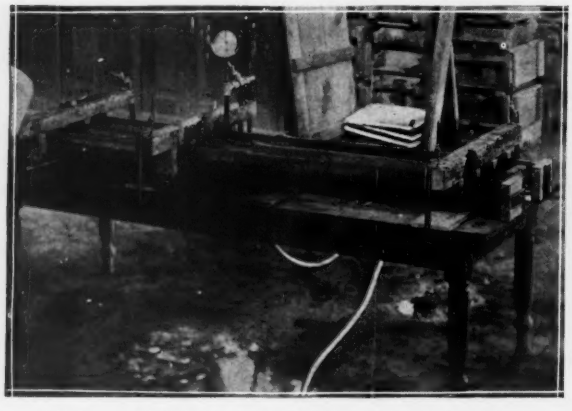


FIG. 1. CONDUIT AS ARRANGED FOR THE TESTS

Three tests were made, 2 subjecting the conduit to water pressure and one to air pressure. Each test was on 2 lengths put together, jointed in the regular way. Through the center, from end to end, a ½-in. iron bolt was passed which held in place a rubber gasket and a block of wood 8 by 8 by 1¾-in. by an iron washer and nut at each end. The nuts were tightened only enough to prevent the water from leaking.

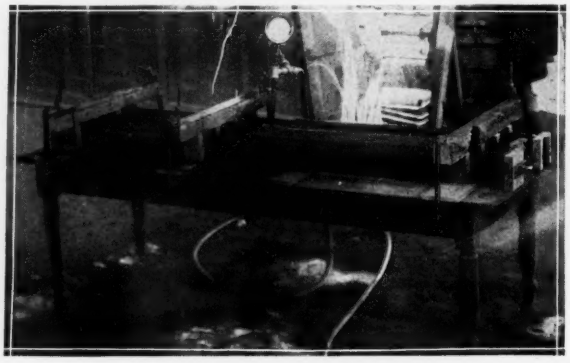


FIG. 2. BURSTING OF PIPE ON 1ST TEST

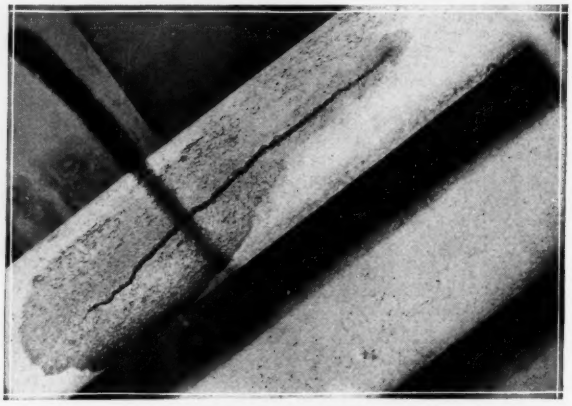


FIG. 3. CLOSE VIEW OF THE SPLIT ON THE 1ST TEST

Into the side of the conduit was screwed a ¾-in. iron pipe and through this pipe the pressure was applied. The pipe was screwed directly into the wall of the conduit and was held only by the standard ¾-in. threads which had been tapped into it, no iron saddle or other device being used.

FIG. 4. THE BREAK FROM AIR PRESSURE

Figure 1 shows everything ready for the test. The pressure was applied gradually, and Fig. 2 shows the pipe opened at 75 lb. to the square inch. Figure 3 gives a clearer idea of the break.

The second test was with the same arrangement as for the first, but in this, the pressure was applied suddenly, the conduit bursting at 80 lb. to the square inch.

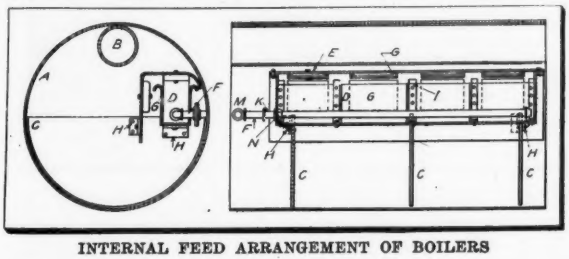
Knowing that if used for irrigating purposes, high places along the line might fill with air, an air pressure test was made. Using the arrangement as for the water tests and raising the pressure gradually, the break occurred at 88 lb. Figure 4 is the result of this test, and shows how uniformly strong the walls of the conduit are. Had there been any particularly weak spots in the walls a blowout would have occurred in that particular spot instead of the break which took place.

INTERNAL FEED ARRANGEMENT OF B. & W. BOILERS

By F. O. Wells

FOR some time I have been trying to overcome pitting in the lower 4-inch generating tubes of the B. & W. boilers in this vessel. I have looked up many references in regard to corrosion in boilers and most of them have plenty of reference to the corrosiveness of the water elements, but very few have anything to say in regard to air in the feed-water. I believe, that if we could exclude all air from the feed-water it would almost stop the corrosion entirely. The B. & W. Boiler Co. has been experimenting for some time along these lines and has finally adopted a spray pan. It consists of the feed pipe being led into the drum and has a short turn upward. A baffle is fitted over the end of the pipe so that the feed-water is discharged through the end of the pipe and against the baffle and falls to the water level.

I thought, that if, by some arrangement, the feed-water could be injected in the form of a thin sheet of water, that this would give an easy escape for the air. With this object in view, I have recently installed an



INTERNAL FEED ARRANGEMENT OF BOILERS

internal feed arrangement, consisting of the old internal feed pipe (which is a perforated pipe and extends for about ¾ of the length of the drum) placed in a box and so arranged, that the water is discharged upward and as the box fills, the water overflows at the top and drops to the water level in a thin sheet. On the drypipe side of this box, a baffle is fitted to extend from the water level up, and over the box, and down a short distance on the opposite side. This prevents any lifting of water. In the box and on the baffle plate, 12 additional zincs are fitted in baskets to take up the extra action in the drum.

The box is placed at about the center of the drum and is supported on the drum swash plates. The feed water is heated to about 220 deg. in the feed heater, and by this box arrangement, it is heated, after entering the boiler, to about the same temperature as the steam. This high heat rapidly expels the air, and by having zincs fitted in the box and on the baffle plate, the action is taken up before it enters the headers and tubes. It is noticeable, that the efficiency of this boiler has been increased in its steaming power, that is, it seems to be easier to hold the steam while doing the same work as formerly.

In the book "Marine Steam," published by the B. & W. Boiler Co., it is stated that there is another reason for heating the feed water, aside from the obvious saving of heat units, and that is the fact that the boiler steams more economically when using hot feed water than when using cold. This was demonstrated experimently by Kirkaldy, of England, and the theory advanced by M. Normand seems very plausible, namely, that cold water checks circulation in the boiler, and in re-establishing this a certain amount of heat disappears in mechanical work, with a corresponding loss in evaporation. Now the feed water after entering the boiler, is held suspended for a short time in the feed box, that is, from the time it enters the box until it circulates to the top and flows over. While doing this it is heated to a very high degree by the steam. Now the heat units gained through this operation are taken from the steam with a corresponding loss there, but if the above paragraph is reasonable, then it is safe to assume that we gain in the total evaporation, due to a better circulation.

Before this arrangement was installed, no pitting had taken place in the drum, but considerable pitting had taken place in the 4-in. generating tubes. We installed zincs on the handhole plates of these tubes, and while this checked the pitting some, still the corrosion continued. On examination, after using this feed arrangement, the drum was found in the same condition as before (no pitting), and the generating tubes were found to be in the same condition as on the last examination and no signs of further corrosion were found. The zincs were found to be oxidized more than formerly, probably due to the air being expelled in close proximity to the zincs.

After considerable use of this arrangement it seems to be the thing I was looking for, and we are now putting in requisitions for material, so as to install it on all the boilers. It is easily assembled and can be installed by the fire-room force. The accompanying sketch shows the installation, and the box and baffles are made in halves, to allow them to enter the boiler manhole. After being in place, the drum is easily accessible for inspections, and at any time the box and baffle can be removed by coming up on a half dozen bolts.

A is a view of the drum, and B is the drypipe. The feed water enters at either K or M (these being connected with the main and auxiliary feed checks respectively) passes through the pipe F, discharges upward into the box D. A joint is made between the box and pipe by the nut N. The sides of the box are turned over as shown, to prevent the water from running down the sides. E is the bafflle plate and prevents any lifting of water. G are zincs fitted in perforated baskets for protection against corrosion. C are known as the swash plates and prevent the water from rushing rapidly from one side to another when the ship is rolling. The box D is set on these swash plates and secured to the angle

irons. H are division plates, I are put in the box to insure the feed passing over the curved sides of the box for its entire length, thus distributing the feed the entire length of the drum.

From this sketch it is easily seen how hot the feedwater becomes after entering the drum and by falling in a thin sheet to the water level, it is plausible that very nearly all of the air is expelled at this point, and that the action is taken up by the zincs G. This undoubtedly saves considerable corrosion in the tubes. The box and baffle are made of 3/16-in. sheet steel.

I have experienced considerable trouble with the old internal feed arrangement in these boilers, due to vibration causing the bolts on the flanges to loosen and let the pipe fall. With the new arrangement, no trouble has been experienced and the installation is the same as when it was first put in. After installing this arrangement, I carefully tested the water level by the gage cocks as well as by the glass, to see if any false level was given, due to the thin sheet of water passing close to the outlet for the try-cocks, but everything proved satisfactory.

REGARDING LUBRICANTS AND LUBRICATION*

Classes of Oils; Their Uses; Composition of Greases; Choice of a Lubricant

By George J. Stoll

OILS are divided into 3 classes, vegetable, animal and mineral.

Vegetable oils are seldom used for lubrication, being expensive and not desirable for this purpose, both because they have not fine lubricating properties and especially because of their tendency to take up oxygen and dry, forming a gum. It is this property that makes them so valuable in the paint industries where they can be used for a carrier for pigments and protective metal salts.

Animal Oils

ANIMAL oils and fats are also exceedingly expensive, but while not valuable for general purposes have some specific uses where they are particularly desirable, especially when combined in a small percentage with mineral oils as in the compounding of cylinder stocks. Until recently it was believed that animal oils were not replaceable. For instance in the cutting of threads, only recently are we using mineral oils with success. For the purpose of general lubrication the principal, if not the only lubricants now used are petroleum products which form almost the entire output of mineral oils (these being sometimes compounded with animal oils).

Greases

THEN there are greases. What is a grease? Many animal and vegetable oils are strong in animal and vegetable acids. These animal and vegetable acids when combined with lime or other base will form an animal or vegetable salt, which fact is taken advantage of. We can mix together lime, finely powdered and free from grit, and an oil, usually a paraffine or neutral and mix this paste with the acid animal or vegetable oil; the result is a grease. Often the lime is mixed with the oil acid first and the mineral oil added.

Different processes are used in the manufacture of different greases. For instance the most common grease to the engineer is cup grease, in which lard oil or horse oil is used and combined with lime making a hard lubricant into which is mixed under heat animal or petroleum oil. The hard grease would have a smaller amount of mineral oil, the soft a much larger amount. The quality of the grease would then depend upon the quality of the animal oil, particularly on the fineness of the lime, the care in getting proper and thorough combination, and on the quality of the mineral oils used.

* From an address before Louisville, Ky., Association of Stationary Engineers. By courtesy of Frederick L. Ray.

Mineral Oils

AND now for our mineral oils. In the fractional distillation of crude petroleum after the gasolines and then the refined oils have been taken off, there comes off through the coil what is known as paraffine oil, which, when the paraffine is pressed out of it at low temperature, becomes what is known as neutral to be rerun through the still for viscosity or body, at the same time being run for fire test which increases with the viscosity. You also know that that which remains in the crude still after all the other things have been distilled out, is in the instance of Pennsylvania crude, a cylinder stock which is run to a certain point for viscosity and fire test also.

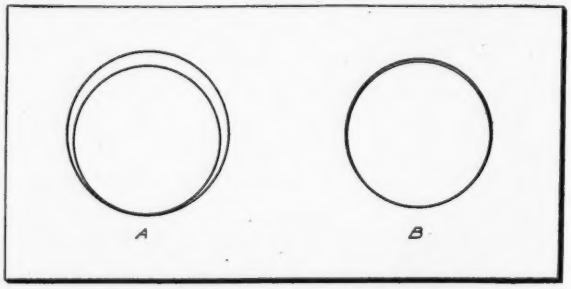


DIAGRAM OF LOOSE, A, AND SNUG, B, BEARINGS

What is Lubrication?

WE now approach our main problem—What is lubrication? What is the purpose of the oil and the grease?

There are 2 primary purposes: 1. Cooling; 2. The forming of a film the molecules of which move among themselves like an infinite number of ball bearings to prevent the rubbing of the bearing surfaces. All mechanical motion produces heat. Heat in machinery produces uneven expansion with resultant increase in friction, hence, to keep bearings cool is one of the important functions of oils.

For lubrication we must apply just the oil needed to the bearing. For instance in heavy loose bearings we find that there is great need for oil of high viscosity or body, because the thinner oil will tend to be pushed aside and will not cling tightly enough to the surface. More especially to illustrate this point, consider a small circle within a larger one and touching it while spinning on its own center. The smaller circle represents the shaft, the larger the bearing in which it runs. From this illustration it

will be seen that the tighter the bearing, the greater the surface on the shaft which touches the bearing in which it is rotating.

Thus on a loose bearing where the circles are not so near the same size there is more of a tendency to rub the oil off. On the close bearing we have the opposite condition; we must have an oil that will be thin enough to get in between the close fitting parts and there lubricate. For instance on dynamos or turbines, we have very snug bearings, and must have an oil of comparatively low viscosity. The question arises, "What effect has fire test?"

You will remember that, for the same viscosity, fire tests vary with the different crudes. Why is it that Pennsylvania oil having light gravity and viscosity is often better than a Western lubricant of much higher viscosity and much heavier gravity? Conceive a bearing in motion; a small speck of dust or foreign matter such as a little particle of waste gets between the surfaces, it may be almost microscopic, yet it immediately produces great heat; a low fire test cheap oil will tend to vaporize. The higher the fire test the slower the oil is to vaporize, and we must have for instance on a dynamo an oil that will not vaporize, but will remain there and cool such a heated condition immediately; an oil that will go to the spot. Were it not for just such trouble as this we should seldom have trouble in lubrication.

These principles may seem very elementary, but their proper application will save many difficulties. Recently a salesman called upon a large manufacturing concern, whose buyer said, "I take a pretty good oil, give me a good oil, good body, I have been paying 18 cents a gallon." The salesman accordingly ordered a heavy, very viscous engine oil to produce the body desired. He did not know anything about the conditions inside the plant, but took the man's statement that he wanted body to the oil. Now then, that plant had very rapid moving machinery with tight, close bearings. The oil was too heavy to "get to the spot" quickly and the result was disastrous. What he should have had was light bodied oil of an entirely different character. Both were the same price. On one the emphasis was placed on "viscosity" on the other "fire test."

Before leaving this division of lubrication we ought to mention the use of material like graphite, plumbago, etc. These are primarily fillers which fill up scratches or imperfections in the surfaces making almost perfect smoothness. They might even produce an easily cut surface over the hardened metal and thus reduce friction considerably, but the function is not like that of the oil which forms a film to keep the surfaces from rubbing.

Cylinder Oils

NOW regarding lubrication within the engine cylinder. We must have an oil that will atomize with the steam and get to the cylinder wall to produce lubrication around the piston head. For the purpose of assisting both in the atomizing and the lubrication that is to help the oil emulsify, animal oils as low in acid as possible are often used.

Cylinder stock of about 600 deg. F., fire test, as free as possible from any taint of tar, and compounded properly with animal oils, is usually the best for ordinary wet steam, because it spreads better in this medium than does the mineral cylinder oil, or the higher fire test goods. Of course in many instances where the exhaust steam is used over, it is impossible to use a compound oil. For the high pressures which have high heat it is usually desirable to use an oil of about 650 deg. fire test unfiltered, free from tar, and any compounding that is done must be done with great care, because poor compounds of animal oils are subject under high heat to be broken up into acids such as stearic-acid which will attack the walls of a cylinder, pitting it seriously.

It will be seen from this that the engineer has but a few elements to work with, but can compound them in an almost endless variety, and that this must be done carefully. It might be likened to the painter that has few primary colors from which so many different results can be obtained. Not only must first-class stocks be used, but they must be carefully and intelligently applied.

MISDIRECTED ENERGY

A Decision Aided by a Breakdown, Arrival of Machinery and the Night Man's Soliloquy

By I. H. P.

IN due time the excavation was made and the forms erected; engine hold-down rods were hung from the template and the concrete poured, 9 ft. thick, 18 ft. long, and 14 ft. wide, as per specifications and drawings by the engine builders.

Two 150-hp. return-tubular boilers were dismantled and taken out to make room for the gas producers of like capacity and for which concrete bases and pipe tunnels were built alongside the only remaining boiler, a 200-hp. Stirling.

A short time prior to the arrival of the engine, the question of which steam engine to abandon had been a source of considerable thought to the management, as the limited space inside the building precluded the possibility of using more than one steam engine until the new unit was ready, and the matter was about to be solved by pitching a nickel into the air, when the problem settled itself in a very thorough and final manner.

The Corliss had about all she wanted to get away with the maximum load, but was more economical, whereas the automatic would carry the big jags but was an awful steam eater, which together with a bent crankpin, made it an undesirable citizen. On the other hand, the 4-valve was speeded up to 135, had a blacksmith's strap around the main pillow-block, and a prop under the bottom guide to hold her together while the trolley-car tried to make the grade at the west end of town. Taken by and large, for and against, they were both what an insurance man would call bad risks, and about a toss up as to which one was the worse.

As was said before, it was while this question was agitating the giant mind of the management that very suddenly, at the psychological moment, as it were, one morning, while the engineer was busily engaged in halfsoling a pair of shoes with an old piece of belt leather, the Corliss sucked over a slug of water too big for the exhaust valve to handle, or for some other reason; gave a hiccough, burst through the mended main bearing, dropped the wheel and crank into the pit and pulled part of the valve gear off.

After being duly pronounced a wreck, the faithless cripple was further dismantled and hustled out of the way, and foundation for the new 200-kw. 3-phase generator was started. The electrical apparatus was at this time in nearly the same crippled state as the engines, and it had been resolved to replace the old single-phase, 133-cycle, 1100-volt equipment with new

2200-volt, 3-phase, 60-cycle generators, and it was not long before they and the new switchboard began to arrive and be put in position.

Meanwhile the gas apparatus had made its appearance and the 4 cars were unloaded, assisted by the expert advice received from a large and enthusiastic audience of noncombatants, who hazarded many a weird guess as to the "heft" of the 2-piece 32,000-lb. flywheel, the 4-ton crankshaft, and divers other pieces they wot not of; one old graybeard, upon noting the cranks set together, stoutly asserted that the engine couldn't be made to run right. At some past period in his uneventful career he had, perhaps, seen twin steam engines with cranks 90 deg. apart, and this bit of observation had stayed by him.

The night man hardly slept at all—nights—any more, but could be seen prowling around over the new engine with a lantern, chuckling to himself, and soliloquizing in this fashion:

"Gee whiz! Crankpins 9½ in. in diameter, and would you look at the bore, 21½ in., and the stroke 32 in. Look at those cylinder-head studs, 24 of them and 1½ in. apiece. Say, this is some old girl, believe me; now I wonder what the deuce these holes are for in the side of the frame. They didn't put them there for fun, I don't suppose, yet I can't see—— Oh, well, if I don't know all there is to know about this old kid in a few short weeks I'm a duffer." Turning toward the producers—"and think of using hard coal! The boss says it will only burn about 2 tons a day. Pretty soft for Mister Stoker, what? No boiler feed pumps, no boilers to wash, no heater to clean. Oh, what a snap! Why, there won't be no work for him at all that I can see, except——"

Here the pop-valve gave the few seconds warning most spring loaded valves give before opening wide, and our enthusiast hastened inside to start the pump.

(To be continued.)

PREPARING FOR INSPECTION

Directions for Preparing a Boiler for Inspection Are Given as Follows by the Hartford Steam Boiler Inspection & Insurance Co., in The Locomotive

THE summary of these directions is to get the boiler reasonably cool, reasonably dry and reasonably clean.

In the matter of cooling, first let the fire die down and burn out, or in urgent cases pull the fire. Then close all doors and open the damper, allowing the boiler to remain in this condition until the gage shows no pressure, when the furnace should be cleaned of all ash, clinker or coal still remaining so that the brick work of the setting may cool. It is important that the water be allowed to remain in the boiler after the pressure has fallen to zero and while the brick work is cooling to avoid danger of serious overheating of the boiler from the heat still in the brick.

Cooling Down

TO cool the setting most effectively, keep the damper open as before and open the ash pit doors seeing that all other doors are closed. Under no circumstances should the front connection doors be opened as this will kill the draft and interfere with the circulation of cool air through the setting. If the open damper cuts down the draft of other boilers too much, it may be partly closed but should remain open as wide as possible. The time required for proper cooling of the setting depends on the amount of brickwork. If the setting is light, 3 hours may be enough, but with a massive setting a longer time will be required.

When properly cooled down the boiler may be blown out and the hand and manhole plates removed, after which it should remain with the doors and dampers as before so that the draft may draw pure air into the upper manhole and out through the hand and manholes which open into the setting, thus tending to dry the interior and fill it with pure air for the inspector to breathe.

Drying

IF cooling has proceeded as above stated, there will be little to say in regard to getting the boiler dry. It is common practice to wash out a boiler as soon after blowing down as possible, so that mud and sediment may not bake on to form hard scale, but, if the boiler has been cooled slowly as directed, the washing out can be done after inspection and the boiler will be dry enough to enable an inspector really to judge of its condition. Leaky stop valves on pipes leading to live boilers will keep the boiler wet and uncomfortable.

Cleaning

THE request for a reasonably clean boiler was intended to apply particularly to the fire side. Loose ashes should be raked from the back connection or combustion chamber so that the paving brick may cool, and the fire side of shells, heads and exposed tubes should be swept with a broom. These parts must be examined minutely, and the inspector is greatly impeded if he must brush soot and ashes off at the same time. The boiler should be cool enough for a man to stay in long enough to complete his examination properly and without real difficulty, and the presence of vapor requires a boiler to be cooler than if it were entirely dry.

SPECIAL HYDRAULIC ENGINEERING

An Emergency Coffer Dam and Another Kind

I'LL bet that the poor fellows down in the flood district have been having a time of it with their power plants. That reminds me of a lad who "ran engine" at the Michigan Carton Co., where they made these packages for Corn Flakes (free advertising) and practically all other breakfast foods in the city.

The river came up on a rampage one day. Wise kid that he was, he had connected an old duplex pump to the flywheel pit for such an emergency. But this time the water came right up to the plant and began to run in the engine room door, which was 3 ft. lower than any other. He got some matched boards off a packing box, and with some Rainbow packing (quite appropriate) for gaskets, nailed up the doorway. Still the water rose and he added a board. It looked skittish all right but he managed to keep 'er hot and the factory in operation.

The water began to fall and he was congratulating himself that he was "some hydraulic engineer," when a railroad tie came down the flood and biff, away went the boards over the doorway and before he could do a thing, the water was over the grates and the main belt thoroughly soaked. Then he used the other kind.

That little fellow showed that he was made out of the right kind of stuff.

FOREIGN DEVELOPMENT IN THE POWER PLANT FIELD

Electric Lighting by Luminescence and Incandescence

By J. H. Blakey

M. KAMMERER discusses this subject in the Bulletin de la Societe Industrielle de Mulhouse. It will be well, in considering this question, to understand just what is meant by the word luminescence. A luminescent radiation is one produced at a temperature below that at which bodies are commonly incandescent. It is used also to indicate those phenomena of light which are more intense than correspond to the actual temperature.

The Geissler tube can be utilized for lighting only with the Moore automatic feed valve; the light which it emits diminishes rapidly, in fact, and ends by disappearing entirely on account of the increasing rarefaction of the gaseous medium. The conductibility of a gaseous atmosphere augments, up to a maximum; from this maximum it diminishes rapidly in proportion as the vacuum increases. Fig. 1 shows these variations for nitrogen: the maximum conductibility giving the best luminous efficiency being maintained only between the limits of pressure of about 0.0394 to 0.0315 in. of mercury. The efficiency expressed in watts per candle power is represented by the curve of Fig. 2. The Moore automatic feed valve determines the maintenance of the pressure between these narrow limits.

In these luminescent tubes different gases may be used. Nitrogen gives a rosy light; hydrogen, greenish blue; carbonic acid, a bright green, varying from yellow at the positive pole to blue at the negative; air gives purple-red at the positive to violet-blue at

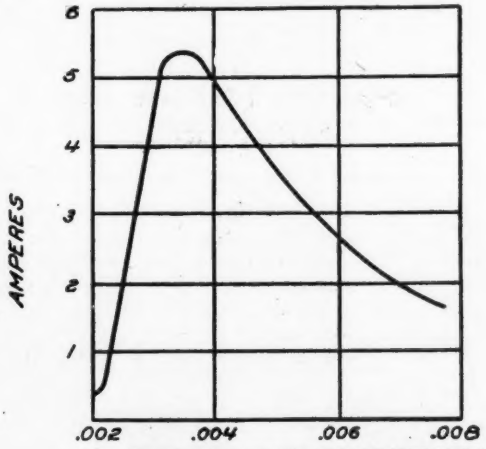


FIG. 1. CONDUCTIBILITY OF RAREFIED NITROGEN

the negative; neon gives a bright red light, and recently a new lamp has been invented in which the gas is a combination of mercury and cadmium vapors, which gives a white light.

The difference of potential necessary at the terminals of a tube increases with its length. It must be much greater for nitrogen or carbonic acid gas tubes than for neon, which has the highest conductibility.

The luminous power of the tubes depends upon the gas chosen and the intensity of the current. Nitrogen tubes have a luminous power of from 13.7 to 15.25 candles per foot of length; neon, about 61 candles. The consumption is 1.53 watts per candle power for a nitrogen tube of 125 ft. long; from 2 to 3 watts per candle power for a similar tube of carbonic acid gas and from 0.7 to 0.9 for neon. It is true that arc lamps have greater efficiency and produce a candle power with 0.5 or 0.6 watt, but incandescent lamps with metallic filament consume 1 to 1.5 watts, lamps with carbon filament, 3 to 4 watts per candle power.

But lighting by luminescence differs essentially from lighting by incandescence. The tendency is to augment the luminous efficiency, and for that purpose to increase the temperature of the material brought

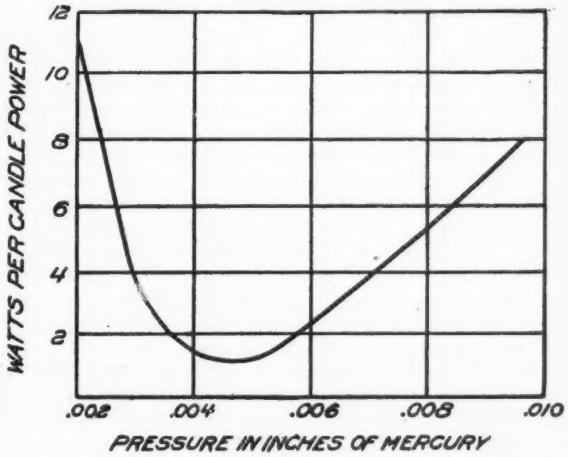


FIG. 2. EFFICIENCY OF MOORE TUBES IN WATTS PER CANDLE POWER

to incandescence; the consequence of this is the necessity for diffusion with lamps of too great brilliancy, the ground glass globes or other agents used absorbing as much as 60 per cent of the light produced. The light from tubes of rarefied gas is, on the contrary, so soft that there is no need of diffusion. If lighting by Moore tubes is compared with that from other sources after diffusion, it will be found that the lights are of about equal value as measured by candle power, with this difference, that furnished by the Moore tubes is more uniform and a little more powerful.

Investigations by the United States Bureau of Mines on the ignition of mine gases from the filaments of broken incandescent lamps have shown that such ignition can take place if the breakage is such that the gas reaches the filaments while they are still incandescent or if the broken pieces of the filament cause a spark when the lamps are smashed. This may take place with several sizes of both standard and miniature lamps.

Copies of the bulletin describing the results of these tests as given by Messrs. H. H. Clark and L. C. Ilsley, may be obtained from the Director, Bureau of Mines, Washington, D. C.

Do good with what thou hast; or it will do thee no good. If thou wouldst be happy, bring thy mind to thy condition, and have an indifferency for more than what is sufficient. —William Penn.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

INDUCTION MOTORS, PART II

Single-Phase Motor

By John A. Randolph

SINGLE-phase motors act upon the same principle as polyphase motors. Aside from the special starting apparatus employed, the construction of the single-phase machine is, in general, similar to those of the polyphase type with the exception that its stator winding consists of but one circuit whereas in the polyphase winding there is a separate circuit or winding for each phase employed.

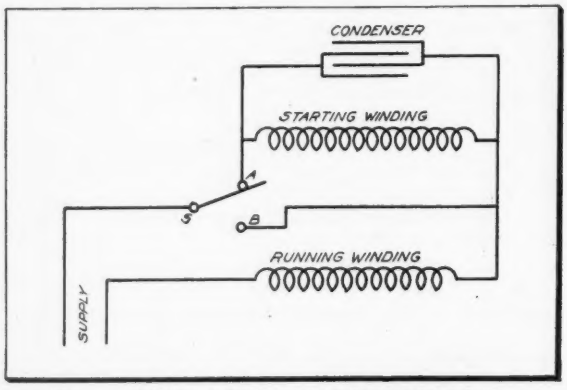


FIG. 1. COMMON METHOD OF PHASE SPLITTING

A characteristic of the single-phase motor, however, that does not exist in those of the polyphase type, is that it will not start without the assistance either of external force or of special electrical appliances designed to produce the required torque. Small motors may be started by giving the motor a few turns by hand, but this means is impracticable with the larger sizes, hence other methods must be used. The most common of these consist in phase splitting and in the use of the repulsion principle.

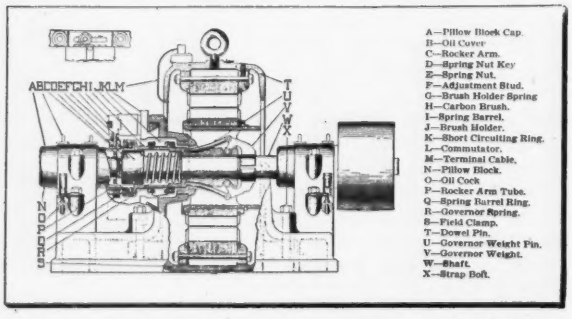


FIG. 2. CROSS-SECTION OF WAGNER SINGLE-PHASE MOTOR

Phase-splitting Method of Starting

IN this method, 2 sets of stator windings are used, one consisting of a main or working winding and the other of an auxiliary or starting winding. These are both in use at starting and are fed from the same mains. The currents in the respective windings, however, are caused to differ in phase by approximately 90 deg., the effect upon the rotor being the same as that of a 2-phase winding. The rotor therefore starts without difficulty. When full speed is nearly reached, the starting winding is cut out leaving only the working winding in circuit.

A common method of phase splitting consists in shunting a condenser across the starting winding as shown in Fig. 1.

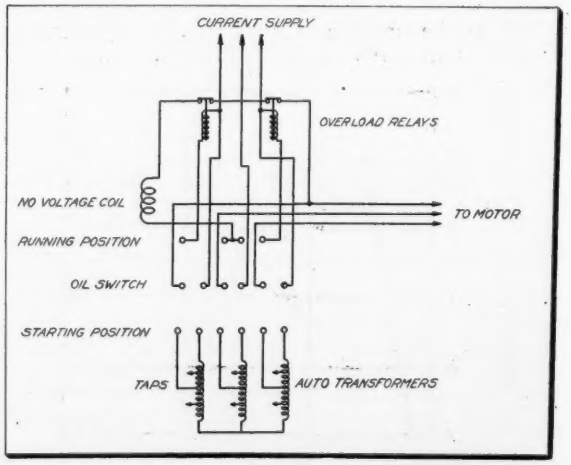


FIG. 3. DIAGRAM OF CONNECTIONS FOR 3-PHASE STARTING COMPENSATOR

This causes a lag of current in the starting coil which produces the required difference in phase. As soon as the necessary speed is reached, the starting winding is cut out by moving the switch S from contact A to contact B. Another method of attaining the same result consists in the use of a noninductive resistance in place of the condenser.

Repulsion Motor Principle

IN the repulsion method the rotor winding is of the ordinary closed-coil direct-current armature type, the coils being connected to a commutator in the same manner as in the direct-current machine. Carbon brushes are placed upon the commutator, but their position is shifted a short angular distance from that

which they would occupy in a direct-current machine. The brushes are short circuited through a resistance either external to the machine or contained in the shortcircuiting medium itself. The function of the resistance is to keep the induced currents more nearl phase with the stator field thereby producing greater torque. The rotor thus wound and connected acts, at starting, like the armature of a repulsion motor, rotation being produced as soon as the power is applied.

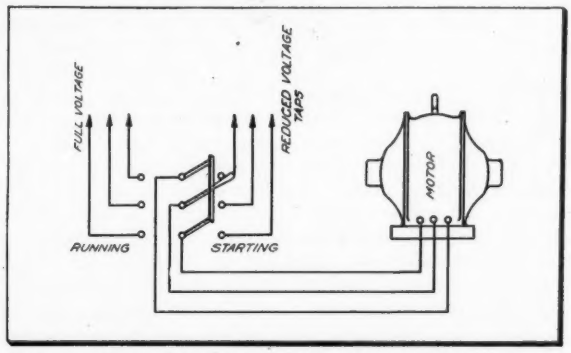


FIG. 4. DIAGRAM OF CONNECTIONS FOR STARTING 3-PHASE MOTOR FROM TAPS ON SERVICE TRANSFORMERS

When full speed is nearly reached, a centrifugal governor mounted upon the shaft actuates a copper ring causing it to come into contact with the commutator segments, thereby completely shortcircuiting the winding. As soon as this action takes place, the brushes are removed from the commutator. The shortcircuited winding now acts similar to that of a squirrel-cage rotor.

Wagner Single-Phase Motor

IN Fig. 2 is shown a motor using the repulsion method of starting and made by the Wagner Electric Manufacturing Co. of St. Louis. The commutator is of the disk type and is designated by L. Bearing upon the commutator, during periods of rest, are the carbon brushes H. The centrifugal governor weights are

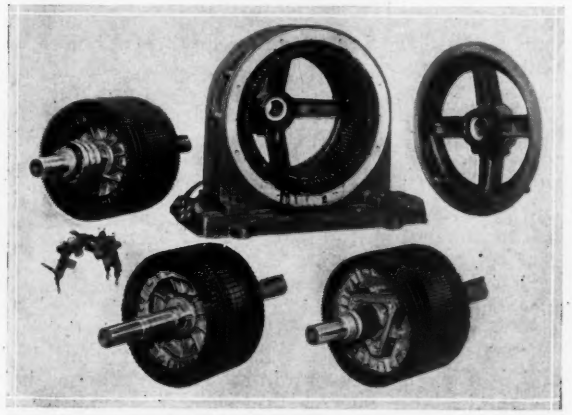


FIG. 5. STATOR AND 3 TYPES OF ROTORS FOR INDUCTION MOTORS

marked V and the shortcircuiting ring K. The carbon brushes are shortcircuited through a resistance, either self-contained in the connecting lead, or located externally to the machine. At starting, the motor acts on the repulsion principle as previously explained. As the speed increases, the governor weights V are forced outward from the shaft, imparting their motion, in turn, to the pins U. The latter act upon the spring barrel I forcing it against the spiral spring R. When full speed has been nearly attained, the barrel I, moved outward by the action of the governor, causes the shortcircuiting ring K to come into contact with the segments of the commutator L. Moreover, the brushes now subjected to the outward movement of the barrel I are, in turn, forced away from the commutator leaving the latter shortcircuited, the result being that the rotor now acts like the squirrel-cage type.

As soon as the motor is stopped, the spring R, no longer subject to the centrifugal action of the governor weights V, forces the brushes, shortcircuiting ring, and movable governor parts back to their original position. It will thus be seen that the internal starting mechanism is entirely automatic.

Starting Methods Used with Single and Polyphase Motors

IN view of the self-induction of its windings, the induction motor could be thrown, at starting, directly across the supply lines without injury to the motor itself. There are conditions, however, external to the motor which often render such a procedure objectionable. One of these is, that in large motors, especially when starting under load, the current taken from the lines is so heavy that the voltage is momentarily reduced, thereby affecting the equilibrium of the entire system, which in most cases is decidedly objectionable. Moreover, when the motor is thus brought quickly up to speed, the belting, shafting and machinery connected to the motor suffers excessive strains injurious to the parts affected. With motors under 5 hp., these features are not so pronounced, hence they are usually thrown directly across the lines at starting. However, with motors of larger size, it has been found necessary to increase the speed gradually. There are several methods of doing this, one of the most general of which is the use of the compensator or autostarter.

The Compensator

THIS consists essentially of 2 or more auto-transformers, a controlling switch, and a suitable case. Its principle of operation consists in the reduction of the voltage at starting by connecting the motor to intermediate taps on auto-transformers. An auto-transformer is essentially an impedance coil arranged with taps from which currents may be taken at different voltages, this being possible on account of the drop due to the self-induction of the coil. A common method of connecting the transformers in a compensator designed for a 3-phase circuit is shown in Fig. 3.

The transformers are connected as shown, to one side of the starting switch. When the switch is in the starting position, only a fraction of the full voltage is applied to the motor, owing to the current being taken from the intermediate taps. When the switch is thrown over to the running position, however, the transformers are cut out and the motor is supplied with current at full voltage.

As a protection against excessive currents, overload relays are connected in the running circuit. The relays will not act as long as the current remains normal, but as soon as it becomes excessive the magnetic action of the solenoid upon the iron core or plunger will cause the latter to shift its position, thereby opening the circuit through the no-voltage coil shown in the diagram. The plunger of the latter is connected to a tripping device on the starting

switch and when allowed to drop will therefore cause the latter to open and stop the motor. This takes place as soon as the circuit through no-voltage coil is opened by the overload relays. The same result will ensue if the power supply from the mains is stopped by any cause. The motor is thus automatically protected at all times.

Other starting devices are sometimes used which are similar to the compensator above described with the exception that non-inductive resistances are used instead of auto-transformers. In this case the device acts on the same principle as the starting rheostats used with direct-current motors.

The compensator is used only in connection with the stator winding of the motor. Another method is used, however, which is applied to the rotor circuit, the rotor, in this case, being necessarily of the wound type. A resistance either self contained within the rotor, or placed externally, is inserted in the rotor circuit. When it is carried by the rotor, it may be controlled by a hand operated switch actuated through the hollow shaft, or it may be operated automatically by means of a centrifugal governor. When placed outside the motor, the terminals of the rotor winding are connected to slip rings which in turn are connected through contact brushes to the resistance, the latter being cut in and out of the circuit by means of a switch or controller.

A very common and simple method consists in the use of reduced voltage taps on the service transformers, the taps being connected to one side of a double throw switch. The connections are as shown in Fig. 4.

When the switch is in the starting position, the motor receives only a fraction of the full voltage. When the maximum speed attainable with the reduced voltage has been reached, the switch is thrown over to the running position, connecting the motor directly across the lines and bringing the speed up to its full normal value.

This method has the advantage of dispensing with the inconvenience and expense attendant upon special starting apparatus. It has the disadvantage, however, in cases where the transformers are located at a distance, of requiring the installation of long extra lines, which is expensive and inconvenient. Moreover, it is impracticable unless the transformers are provided with intermediate taps suited for this purpose. In small sub-stations and other cases where the transformers are provided with the necessary taps and are near the starting switch, the method is well suited and is, therefore, often used under these conditions.

Speed Variation

IT is often necessary for crane work, hoisting, and other purposes to use different speeds. To attain this result, a variable resistance is used in the rotor circuit in conjunction with a compensator in the stator circuit. The various transformer and resistance connections are manipulated by means of a controller similar to that used for street cars, the movable element of which consists of a cylinder which carries the contacts necessary for the different stages. The cylinder is revolved by means of a handle at the top of the case. In thus varying the speed the principles employed are exactly the same as those used in starting by the compensator method or by the variation of resistance in the rotor circuit.

In Fig. 5 are shown a stator, bearing brackets, and 3 types of rotors made by the General Electric Co. The rotor with the slip rings is designed for use with an external resistance. The one in the center is of the squirrel-cage type while the rotor at the right is equipped with an internal resistance self-contained within the rotor. The choice of these depends upon the purpose for which the motor is to be used and upon the conditions of the power supply.

ELECTRIC ELEVATORS

Operating Difficulties, How They are Recognized and Overcome

By J. C. Lee

THIS is not intended for anything but a simple explanation of electric elevator troubles and their remedies, as I have learned in the past year.

When breaker on control board opens and refuses to stay closed, we know the current is interrupted for some reason. There are 2 small fuses on rear of board, see that these are O. K. There is a small switch in car under the controller which can be thrown applying the brake; if for any reason this switch has been thrown, it will hold circuit open and breaker out until thrown back. Again the rope on drum may be overlapped, thus striking the rod under drum and opening the breaker. The limit switches may not be in contact. These are located at top and bottom of the shaft on some machines, and at top in other types; their purpose is to break the circuit applying the brake when operator allows car to overtravel.

Another cause of trouble is failure of the magnets to throw in. There are 3 of these controls; one up, one down, and one speed. This can usually be remedied by unscrewing bottom plate under solenoids and removing the brass tube that is around the plunger. This tube frequently becomes dirty, thus making a poor conductor. Simply take out and wipe clean, also wipe plunger and replace tube, which usually ends the trouble. Don't use sand or emery paper, and remember oil will soon collect enough dirt to put the plunger out of operation, so if oil is used, be very sparing with it.

See that carbon contacts releasing brake connect just before contacts controlling direction make circuit, so that the brake is in release just before current begins to move motor. These are small, round carbons such as used in arc lamps and are adjustable where the contacts make, the solenoid releasing the brake on armature shaft compresses the springs releasing the brake.

Failure of brake to release is due to an open circuit always. Occasionally the wires operating the releasing magnet on the shaft brake become broken and car will remain standing until repaired.

There are 3 brakes in the machine, the electrical mechanical brake described above, which in turn operates a drum brake through a rock shaft.

This drum brake has also a magnet control, the action of magnet drawing in the core or plunger, holding the brake in tension until current is applied when release takes place. Both these releasing magnets are adjustable. The one on the armature shaft has in addition to plunger adjustment, a form of locknut which is used for increasing or decreasing tension of springs applying brake.

In addition to these brakes, the motor tends to stop itself by becoming a dynamo when the line circuit is broken by operator placing handle of controller in center. The current in armature passes through a resistance, thus retarding speed of motor.

On the magnet control board are, first, 3 solenoids actuating the direction magnets and speed. Below these to the right are 5 single switches which are in resistance and gradually cut in when car starts; when all are in, car is up to speed.

Opposite these 5 are 3 smaller switches which are actuated by the motor becoming a dynamo and cut in the resistance as explained before.

Below is the circuit breaker; occasionally loose connections are found here and breaker will, of course, stay out.

Opposite breaker is a small magnet which controls the field of motor; the field resistance must be cut out before the 5 speed magnets pick up. Should this field magnet not cut in, the electric brake will be applied, in other words, the motor will be working against a high resistance. As all magnets are adjustable in regard to contacts, smooth running of machine can easily be obtained.

Between the up and down controls is a balanced lever; when either up or down is in contact, this lever forces opposite plunger down and it is held there by the small solenoid which is directly under the operating one.

Keep brushes on motor in shape. Have all contacts clean and making true. Do not allow them to wear too thin and overheat. Adjust brake to obtain an easy stop. Keep all wire contacts tight; use proper oil and bronze gearing, and with clean plungers and tubes in controlling solenoids you will have little trouble with this type of elevator. There are 2 more causes for failure of breakers to stay in, in addition to the open circuit; an overload or too high voltage will open breaker.

MOTOR MAINTENANCE

How to Prevent Trouble by Regular Inspection and Repairs Before the Failure Occurs

WHERE will it give out? If you knew that, and when, you would take down the motor and fix that part, the day before the break was to occur. Then why not go over it and fix the part anyway, even if it is a month before trouble is due. It will take less time than after the weakness gets worse. Which motor? Why all of them, of course; then you will be sure not to miss the one that needs attention most. And so regular and efficient inspection and overhauling is the first requisite to preventing trouble. Not expensive, either, for if there is no repair needed, the inspection will be short, and anyway keeping the motors regularly cleaned and oiled will better the efficiency and prolong their life.

Well, then, what to look for in inspecting. Here are some points mentioned by J. C. Thirlwell in the General Electric Review.

Keep all points at which a ground or a flashover might occur well coated with insulating paint or varnish. An exra coat, even if it doesn't seem to be needed, can do no harm; and see that the new coat is dry before the motor goes back into service.

Blow out all windings with compressed air, or failing that with a strong bellows or tire pump. A coat of dust, especially if metallic particles are mixed in, can make a beautiful short circuit and cause large chunks of trouble.

Watch for oil about the commutator and brush holders. Oil causes rapid deterioration of coil insulation and gathers dirt fast. On older types of motors, the oil sometimes works along the shaft and spatters over the entire motor. Clean up thoroughly; and then fix the bearings so that it cannot happen again. Determine the minimum safe amount that will last between inspections and see that just that, no more, no less, is used each time.

Oil alone will not insure against hot bearings. Go over the fit of the bearings, alinement of the motor, and, if geared, the proper meshing of gear and pinion. Look to the proper feeding of oil by feeders, oil cups or rings. With the bearings in the best condition, a small amount of oil will give better lubrication than a flood where the bearings are in bad shape.

Watch the brushes; the fit on the commutator, spacing, brush tension and condition of the brushes. A brush that gives excellent service on one type of motor may wear rapidly or chip or break on another. If this condition is found, try a different make or style of brush until one is found which is satisfactory.

Clean the commutator and remove any beading over of bars which may tend to short circuit adjacent segments. If there is high mica, file it down, or even undercut it in the slots with a hack saw. If there are flat spots turn up the commutator in a lathe, but be cautious about the use of sandpaper and never use emery cloth.

Go over brush holders and yokes carefully and, if in doubt, remove them and inspect the insulation, replacing it with new if necessary. Clean all parts carefully and give them a good coat of shellac, letting it dry thoroughly.

In going over the bearings, the shafts should be calipered carefully and if high or low spots are found exceeding 0.01 in. the shaft should be trued up in a lathe. Mr. Thirlwall advocates babbiting all bearings to a smaller inside diameter than the shaft size and boring in a lathe or mill to 0.01 to 0.015 in. larger than the calipered shaft size. This compensates for the wear of the shaft in service and by boring central to the fields insures that the armature will be in magnetic balance.

The time between inspections can best be determined by experience, but should be too frequent rather than too seldom, and be sure that a motor is in perfect condition when it is passed.

The keynote is that it costs less in labor and trouble to prevent shutdowns than to repair after defects develop, and the condition of motors under such a system should be so good that delays are unknown. The economy of such a policy, rigidly carried out, will be found surprising.

IT IS ANNOUNCED THAT a merger of public service corporations is to be made that will include the Rutland, Vt., Railway Light & Power Co., Colonial Power & Light Co., Springfield Light & Power Co., Manchester Electric Co., Clarendon Power Co., Claremont Electric Co., and which will be known as the Eastern Power & Light Co., with $20,000,000 capital.

A 6000-hp. plant will be built at Clarendon. Power lines will be built from Clarendon to Wells, and through to the New York state boundary line, extending to West Pawlet and Rupert. Another line will extend from Clarendon through Wallingford to Manchester, while still another will be built to Cavendish, connecting with a 2000-hp. hydraulic plant on the Black River about a mile south of Cavendish and extending thence to Springfield. A line will also be built from Cavendish across the Connecticut River to Claremont, N. H.

ENGINEERS' CERTIFICATE IN NEW YORK CITY

Information Relating to the Department Issuing, and Steps to be Taken by the Applicant for the Same

By Hubert E. Collins

THE subject is of interest to all engineers who wish to be informed on license law and especially to the following:

1. The applicant who has worked the required time in the city.
2. The one from the outside who desires to come to the city.
3. Those who desire the higher grades but now hold one of the lower.

The law relating to the licensing of engineers and firemen as it now stands is as follows:

Laws of New York. Chapter 635

AN act to amend chapter four hundred and ten of the laws of eighteen hundred and eighty-two, entitled "An act to consolidate into one act and to declare the special and local laws affecting public interests in the City of New York," relative to engineers.

Dated MAR 20 1913 191 Expires MAR 20 1914 191

ENGINEER'S CERTIFICATE

ISSUED BY THE

POLICE DEPARTMENT OF THE CITY OF NEW YORK.

Pursuant to Sections 342, 343, 344 and 345 Chapter VIII of Chapter 378 of the Laws of 1901 (CHARTER)

This is to Certify, that ... has been examined by practical Engineers detailed as such by the Police Commissioner, as to his qualifications to take charge of and operate Steam Boilers and Engines in the City of New York, and he was found COMPETENT and a Certificate of the ... Class was granted to him, and permission given to him to take charge of and operate the ... Steam Boiler and ... situated at ... and registered on the books of the Steam Boiler Inspection and Engineers' Bureau as Boiler No. ... the steam pressure of which is limited by law to ... pounds.

Examining Engineer. Officer Commanding Steam Boiler Inspection and Engineer's Bureau.

SANITARY COMPANY

RENEWAL

This CERTIFICATE FOR ENGINEER ... persons named herein to take charge of and operate THE STEAM BOILER MENTIONED, BUT NO OTHER, and will be RENEWED on proof of RESIDENCE OF EMPLOYMENT by ... any person certificating a Steam Boiler in the City of New York without a Certificate from the Department of Police, and any person endeavoring to discharge the duties of an Engineer after his Certificate shall have expired, or been revoked, will be guilty of a Misdemeanor.

For ...

FIG. 1. CERTIFICATE ISSUED BY CITY OF NEW YORK TO ENGINEERS

Accepted by the city. Became a law, May 22, 1897, with the approval of the Governor. Passed, three-fifths being present.

*Chapter 461, Laws of 1900, An act to amend Chapter 635 of Laws of 1897, entitled "An act to amend Chapter 410, of the Laws of 1892, entitled, And act to consolidate into one act and to declare the Special and Local Laws affecting public interests in the City of New York, relative to Engineers, became a law April 16th, 1900.

Eligibility for Examination for License as Engineer

SECTION 1, Chapter 635, of the laws of 1897, Paragraph B, of sub-division 3 thereof, in relation to persons eligible for examination for a license to act as Engineer in the City of New York, is hereby amended to read as follows:

The people of the State of New York, represented in Senate and Assembly, do enact as follows:

*See Section 3b, second paragraph.

Section 1. Section three hundred and twelve of chapter four hundred and ten of the laws of eighteen hundred and eighty-two is hereby amended so as to read as follows:

Section 312. The board of police shall preserve in proper form a correct record of all inspections of steam boilers made under its direction, and of the amount of steam or pressure allowed in each case, and in cases where any steam boiler or the apparatus or appliances connected therewith shall be deemed by the board, after inspection, to be insecure or dangerous, the board shall prescribe such changes and alterations as may render such boilers, apparatus and appliances secure and devoid of danger. And in the meantime, and until such changes and alterations are made, and such appliances attached, such boiler, apparatus, and appliances may be taken under the control of the board of police, and all persons prevented from using the same, and in cases deemed necessary the appliances, apparatus, or attachments for the limitation of pressure may be taken under the control of the said board of police. And no owner, or agent of such owner, or lessee of any steam boiler to generate steam, shall employ any person as engineer or to operate such boiler unless such person shall first obtain a certificate as to qualification therefor from a board of practical engineers detailed as such

Form 138

POLICE DEPARTMENT

TRANSFER OF ENGINEER'S CERTIFICATE

No. ... New York City, ... 191...

THIS IS TO CERTIFY that ... has been re-examined as to his qualifications as an Engineer and found competent to take charge of and operate the ... Steam Boiler and ... situated at ... and registered as Boiler No. ... Police Record, the steam pressure of which is limited by law to ... pounds.

He is transferred to the said boiler upon the application of the owner, as a ... class Engineer.

Certificate expires ... 191...

Captain Commanding Boiler Squad.

FIG. 2. ENGINEER'S TRANSFER CERTIFICATE

by the police department, such certificate to be countersigned by the officer in command of the sanitary company of the police department of the City of New York. In order to be qualified to be examined for and to receive such certificate of qualification as an engineer, a person must comply, to the satisfaction of said board, with the following requirements:

1. He must be a citizen of the United States and over twenty-one years of age.
2. He must, on his first application for examination, fill out in his own hand writing, a blank application to be prepared and supplied by the said board of examiners, and which shall contain the name, age and place of residence of the applicant, the place or places where employed and the nature of his employment for five years prior to the date of his application, and a statement that he is a citizen of the United States. The application shall be verified by him, and shall, after the verification, contain a certificate signed by three engineers, employed in New York City, and registered on the books of said board of examiners as engineers working at their trade, certifying that the statements contained in such application are true. Such application shall be filed with said board.

3. The following persons, who have first complied with the provisions of sub-divisions one and two of this section, and no other persons, may make application to be examined for a license to act as engineer.

a. Any person who has been employed as a fireman, as an oiler, or as a general assistant under the instructions of a licensed engineer in any building or buildings in the City of New York, for a period of not less than five years.

(b. Any person who has served as a fireman, oiler or general assistant to the engineer on any steamship, steamboat, or any locomotive engineer for the period of five years and shall have been employed for two years under a licensed engineer in a building in the City of New York.)

W 10,000 (C) : Form No. 138

Police Department, City of New York.

STEAM BOILER INSPECTION AND ENGINEERS' BUREAU, SANITARY COMPANY.

APPLICATION FOR EXAMINATION AS .....

This blank must be carefully and correctly filled, and **all questions** must be answered in the **handwriting** of the applicant, in ink, and all statements of Vouchers must be in ink and in the handwriting of the person signing each statement.

NEW YORK, ... 190

To the Steam Boiler Inspection and Engineers' Bureau of the Police Department of The City of New York.

I, the undersigned, hereby apply to be examined for a Certificate of Qualification as ..... and on oath declare that the answers made by me to the following questions are true.

QUESTIONS.	ANSWERS.
NAME	
AGE	
RESIDENCE	
WHERE BORN	
WHERE NATURALIZED Give Date, Place and Name of Court	
PLACES WHERE EMPLOYED FOR THE PAST FIVE YEARS, AND NATURE OF SUCH EMPLOYMENT Give Location, Name of Employer, and Length of Time with each	

IN WITNESS WHEREOF, I have hereunto subscribed my name this ..... day of 190

Applicant's Signature, ...

Sworn to before me, this ..... day of 190

FIG. 3. APPLICATION FOR ENGINEER'S EXAMINATION

as apprentice, or while learning such trade, and also any person who has graduated as a mechanical engineer from a duly established school of technology, after such person has had two years experience in the engineering department in any building or buildings in charge of a licensed engineer, in the City of New York.

d. Any person who holds a certificate as engineer issued to him by any duly qualified board of examining engineers existing pursuant to law in any state or territory of the United States and who shall file with his application a copy of such certificate and an affidavit that he is the identical person to whom said certificate was issued. If the board of examiners of engineers shall determine that the applicant has complied with the requirements of this section he shall

VOUCHERS.

THIS IS TO CERTIFY, that we, the undersigned, Engineers holding licenses as such, and recorded upon the books of the Steam Boiler Inspection and Engineers' Bureau of the Police Department of The City of New York, personally know ..... an applicant for a license as a Stationary Engineer, and that we have read his application, and know the same to be true in all particulars.

NAME.	WHERE EMPLOYED.

Date. .....
Name. .....
Location. .....

EXAMINATION.

Construction of Boiler. .....
Connections to " .....
Care of " .....
Construction of Pumps. .....
Operation of " .....
Construction of Engines. .....
Operation of " .....
Previous Experience. .....

REMARKS:

Location of Plant. .....
Boiler No. ..... Name of Building. .....
Owner. .....
Description of Boiler and Apparatus. .....
Date of Boiler Test. ..... Limit of Pressure, ... Lbs.
Date of Last Examination. .....
Grade of Certificate Issued. .....
Examined by .....

FIG. 4. REVERSE SIDE OF APPLICATION BLANK

b. Any person who has served as fireman, oiler or general assistant to the engineer on any steamship or steamboat for a period of five years, and shall have been employed for two years under a licensed engineer in a building in New York City, or any person who has served as a marine or locomotive engineer or fireman to a locomotive engineer for a period of five years and shall have been a resident of the State of New York for a period of two years.

c. Any person who has learned the trade of machinist, or boiler maker or steam fitter and worked at such trade for three years exclusive of time served

be examined as to his qualifications to take charge and operate steam boilers and steam engines in the City of New York, and if found qualified said board shall issue to him a certificate of third class. After the applicant has worked for a period of two years under his certificate of the third class, he may be again examined by said board for a certificate of the second class, and if found worthy the said board may issue to him such certificate of the second class, and after he has worked for a period of one year under said certificate of the second class, he may be examined for a certificate of the first class, and when it shall

be made to appear to the satisfaction of said board of examiners that the applicant for either of said grades lacks mechanical skill, is a person of bad habits, or is addicted to the use of intoxicating beverages, he shall not be entitled to receive such grade of license and shall not be re-examined for the same until after the expiration of one year. Every owner or lessee, or the agent of the owner or lessee, of any steam boiler, steam generator, or steam engine aforesaid, and every person acting for such owner or agent is hereby forbidden to delegate or transfer to any person or persons other than the licensed engineer the responsibility and liability of keeping and maintaining in good order and condition any such steam boiler, steam generator or steam engine, nor shall any such owner, lessee or agent enter into a contract for the operation or management of a steam boiler, steam generator, or steam engine, whereby said owner, lessee or agent, shall be relieved of the responsibility or liability for injury which may be caused to person or property by such steam boiler, steam generator or steam engine. Every engineer holding a certificate of qualification from said board of examiners shall be responsible to the owner, lessee or agent employing him for the good care, repair, good order and management of the steam boiler, steam generator or steam engine in charge of or run or operated by such engineer.

Section 2. This act shall take effect immediately.

(To be Continued)

PRACTICAL MATHEMATICS

Everyday Power Plant Problems Solved by Logarithms

DIMENSIONS of a horizontal return-tubular boiler are 42 in. by 9 ft.; it contains 32 3-in. tubes; what is the horsepower?

The horsepower of a boiler may be figured from its heating surface, standard practice being to allow 11.5 sq. ft. per horsepower. The parts of the boiler included in the heating surface are the lower half of the shell, the tubes and the area of the rear head, minus the total cross-sectional area of the tubes.

Circumference of the shell = $3.1416 \times 42 = 132$ in. nearly. The length, 9 ft. = 108 in., then the total area of the boiler shell is $132 \times 108 = 14{,}256$ sq. in. $14{,}256 \div 144 = 99$ sq. ft.

Circumference of a 3-in. tube is $3.1416 \times d = 3.1416 \times 3 = 9.42$ sq. in. Then $9.42 \times 108 = 1017.36$ sq. in. = area of tube heating surface.

$1017.36 \div 144 = 7.06$ sq. ft. $7.06 \times 32 = 225.9$ = total heating area of tubes in square feet.

Area of rear head = $3.1416 \times r^2 = 3.1416 \times 441 = 1385.4456$ sq. in. $1385.45 \div 144 = 9.62$ sq. ft.

Total cross-sectional area of tubes = $7.07 \times 32 = 226.24$ sq. in. $226.24 \div 144 = 1.57$ sq. ft.

Effective heating area of rear head = $9.62 - 1.57 = 8.05$ sq. ft.

Effective heating area of shell = $99 \div 2 = 49.5$ sq. ft.

Total heating area of tubes = 225.9 sq. ft.

Total heating surface of boiler = $8.05 + 49.5 + 225.9 = 283.45$ sq. ft. Horsepower of boiler = $283.45 \div 11.5 = 24.6$.

Some of the operations in this problem can be performed to advantage by logarithms, for example, the total area of the boiler shell is $(132 \times 108) \div 144 = 99$ sq. ft. In the log table in column 2 in line with 13, find 1206 the mantissa of the log of 132. The characteristic of the log is one less than the number of digits on the left-hand side of the decimal place, therefore log of 132 = 2.1206. In the line with 10 in column 8 we find 0.0334 the mantissa of the log 108; as there are 3 figures on the left-hand side of the decimal place, the characteristic will again be 2, then log of 108 = 2.0334. We now add the logs just found to perform the multiplication in the operation.

2.1206 = log of 132
2.0334 = " " 108

4.1540 = " " product
2.1584 = " " 144

1.9956 = " " quotient

From the sum of the 2 logs we subtract the log 144, the mantissa of which is found in column 4 in line with 14, and is 1584. The characteristic is 2, therefore log 144 = 2.1584.

Opposite 99 in column 0 we find the mantissa 9956, and as the number of figures on the left-hand side of the decimal place is one greater than the characteristic the answer must be 99.

Safe Working Pressure of Boilers

FIND the safe working pressure of a steam boiler 50 in. in diameter with a ⅜ (0.375) in. shell and double-riveted longitudinal joints.

The formula for solving this problem is:

$$P = \frac{T.S. \times t \times \%}{R \times F.S.}, \text{ in which}$$

P = Safe working pressure.

TS = Tensile strength of sheet, assumed to be 50,000 lb. per square inch.

t = Thickness of sheet.

% = Per cent joint efficiency with double riveting assumed to be 0.70.

R = Radius = ½ diameter of boiler.

FS = Factor of safety, assumed to be 5.

Substituting figures in the formula, we have:

$$P = \frac{50{,}000 \times 0.375 \times 0.70}{25 \times 5}$$

This problem can be solved quickly by the use of logarithms. Referring to the log table we find in column 0, opposite 50, the mantissa 6990, of log 50,000, the characteristic is one less than the number of figures to the left of the decimal place which for 50,000 is 4, then log 50,000 = 4.6990. In column 5, opposite 37, we find 5740 the mantissa of the decimal fraction 0.375. The characteristic of a decimal fraction is negative and is one greater than the number of ciphers following the decimal place. As there are no ciphers the characteristic is —1, we therefore add 10 to the characteristic and indicate the subtraction of 10 from the resulting log thus: 9.5740 — 10. In a similar manner we find the log of 0.70 is 9.8451 — 10. The log of 25 is 1.3979 and log of 5, 0.6990.

We now add the logs of the dividend to perform the continued multiplication and from the sum subtract the sum of the logs of the factors in the divisor.

(1)

4.6990
9.5740 — 10
9.8451 — 10

24.1181 — 20 = log of dividend

(2)

1.3979
0.6990

2.0969 = log of divisor

(3)

24.1181 — 20
2.0969

22.0212
20

2.0212 = log of answer

In column 5 opposite 10 we find the mantissa 0.0212 and as the characteristic is one less than the number of places to the left of the decimal place, the answer to the problem is 105 lb.

CORRESPONDENCE OF AN OLD ENGINEER AN HIS SON

MY DEAR FATHER:

Your very welcome letter of a few weeks ago was duly received and of course I was glad to hear from you and to know that both you and mother were well as usual. I suppose that I should have written sooner, but I like to read your letters over every few days as there seems to be something new in them every time I read them.

So, when I find that after reading them over about twice without running across anything that has been skipped before, I take it that I have fully assimilated everything in them, and then begin to think of answering them.

Another reason for being so tardy, is that this new job does not seem to be the snap that I thought it was when viewed from the boiler room or the grandstand of the repair gang. When I first came to the Daneberg Mfg. Co., it seemed that all the engineer had to do was to turn on the steam and keep the engine oiled.

Well, this is so to a certain extent, but then there are so many little by-plays to this simple operation, that it keeps a man on the job right along, knowing that everything is all right and in operating condition. Of course, there is occasionally a "blue Monday," that gets on a man's nerves sometimes, but when these things happen, I think of a little verse that we had in literature back at Tech. and as it was so odd and so applicable to such occasions, I memorized it.

It was one of the few things that I actually memorized, word for word. It goes like this:

"Let's smell of the roses, forgetting the thorns,
Let's smile at the fellow who treads on our corns.
Let's feast on the cherries, and cast out the stones,
Let's eat the good fish, avoiding the bones;
Let's taste of the meat of the nut,—not the shell,
And always remember, Heaven's bigger than Hell."

Yes, I remember something that you wrote about 2 yr. ago, that anybody could "run" an engine,—as long as everything ran all right but that when it didn't, it took an engineer to do it. We have the usual little petty annoyances with gaskets blowing out occasionally, sticks getting in the condenser, and all that run of luck.

Still, I suppose that if everything went smooth all the time, life would be as monotonous as living where it is all summer. So far, however, I have been able to get away with anything that has happened in the power house along this line.

While this place is not the latest, nor is it very old, yet there are a few things that need changing for the better. One of these was the method of oiling the different engines, which had always been done by means of the time honored oil can. The waste oil was caught, however, and poured into a filter in the cellar to be used over again.

It seemed to me that there ought to be some better way than this, and one that was a great deal more reliable, and I gave it a lot of thought. First, it appeared to me that the waste oil ought to run down cellar by gravity instead of part way down and into cans that had to be carried the rest of the way.

One evening when I was over at the Chief's house (no matter what for), we got to talking about several little things about the plant and I brought up the question of oil and lubrication. I explained my idea of the matter to the Chief and as he didn't seem to be inclined to talk, I had to do all of it. Finally, when is seemed that all had been said that could be, he replied about as follows:

"Have you any well defined idea of how to go about such a job if you got the chance?" I told him that I thought so.

"All right then. I'll send you Ed Wilson in the morning and you can work the proposition out together," saying which, he yawned and went to bed, for he hasn't been well of late. So after visiting a while with Hazel and her mother, I went home and worked up a few sketches in the rough.

Next day, we looked the situation over as to how many corners we had to turn with the drain piping and have it as simple as possible. Finally we decided on the main, which was 1¼-in. pipe branching out both ways from the filter in the basement. These pipes were suspended from the ceiling as high as possible and still provide a good fall towards the filter.

Instead of elbows, we used tees and crosses, plugged to suit, so as to provide easy access in case of stoppage with bits of waste which will work in sooner or later and need removing. This main was run to a convenient location near the filter where we located a common kitchen range boiler which had outlived its legitimate field of usefulness on account of 2 small pin holes.

These were plugged with small brass plugs and soldered. A gage was attached near the top and a drain run to the sewer, to take care of the water that will leak through from the rods. Near the filter we placed a 3-way cock arranged in such a manner that, in case of cleaning or repairing this water separator, the oil could be drained directly into the filter, temporarily.

So far, so good. Now, it was simply a matter of connecting the several drain pipes on the engines into this main, and in a few days all of the waste oil ran from the engine into the filter in the cellar by gravity, and we cleaned out all of the old filthy, unsightly pails, pans, and buckets, and washed up with benzine.

Practically all of the oil cups were of the sight feed type and the Chief ordered me enough cup bases for pressure systems and of the right type, all we had to do was to remove the cup, screw in a base fixture and screw the cup into this and go on feeding by hand as usual till the entire system was completed.

While I was on the repair gang, one day I found a galvanized iron tank of about 150 gal. capacity stored up in a loft where it had perhaps been overlooked by the inventory force for several years. Investigation showed that it was made of about No. 10 steel, riveted and soldered. We cleaned it out and put in the connections for a gage glass, a drain in the bottom, and a 1¼-in. connection for the supply about 6 in. from the bottom came next. A connection for the oil pump discharge and a good healthy overflow to connect back to the filter, completed that.

A fine location was found in a clean passageway leading to the works, well lighted and high enough so that we had a head of about 10 lb. above the bearings. A couple of small I beams and a steel plate out of the scrap provided a substantial platform while a landing half way up a stairway made it easily accessible.

Then we ran our oil main down into the basement of the engine room and left a tee opposite each engine and put on a good master valve, after which we ran a pipe to each engine, (2 to the cross-compounds), and came up along the inside of the frame just ahead of the cylinder where we put on a lever handle cock and from there ran a pipe line on top of the frame suported about 2 in. from it, and nice brass bends leading to all of the cup bases.

Before coupling up, a generous blast of air cleaned thoroughly the oil pipe. Then I made a simple pattern for the castings and had them machined in the shop and with a couple of ball checks on each, soon had a single-acting plunger pump an inch in diameter for each engine, which I connected in such a manner as to be operated by a stud on the wrist-plate.

The suction of all of these pumps ran to the filter where they connected into a manifold attached to the pure oil reservoir. A little steam pump for emergency completed the outfit.

During the time that all of this work was in progress, the Chief came in occasionally and looked things over but said little. Oh, once in a while he would ask what so-and-so was for and when explained to him, would nod his head and leave.

Finally the great day of trying it came, and I ordered up 3 barrels of engine oil. The Chief, of course, has to O. K. all requisitions and he came in with the order and asked if I needed all of the oil at once and I said I did, so he had it sent up from the oil house.

The oil pump on one of the engines had been arranged cross-connected so that the oil could be pumped out of the barrel and into the filter. You know, father, there is always so much sediment in the oil barrels, that this seemed to be the best course. So the 3 barrels were pumped into the filter by one engine, and from the filter into the overhead tank by the others.

Why so many pumps? Well, any engine is liable to be in operation alone part of the time, depending on the load. The Chief stood around saying nothing, but I guess he was thinking a lot. Wilson got up and turned the oil into the main and from the main into the branches to the engines in operation, where I turned the lever cock into the distributing pipes.

Then it was simply a case of adjusting the feeds on the pressure system in accordance with the needs, and shutting off the cup feeds,—and the whole system was in operation and working fine without stopping the service of an engine.

The Chief looked the whole thing over again with a careful eye, and when he couldn't find anything to criticise, he came over and said,

"Donny, that is the best thing there is around the whole dump." It isn't often he indulges in such expressive language, but the remark was short and to the point, and made me feel a great deal better than a staid and set speech by Old Prexy, back at Tech.

We had a little trouble though, with the oil guards, etc. They were not used to such profuse lubrication and slopped a little but the ingenious Ed soon restored confidence. Now I let the oil run a stream and find that there is less friction by actual test with the indicator than there was when the oil was fed a drop at a time because it was so hard to take care of.

Anyway, I feel very well satisfied with the whole job, myself. There does not seem to be any waste at all while before it seemed that a barrel of oil "didn't last no time." Even Fred says that he can actually feel the difference in firing, but I guess that his thirst after higher education so late in the game has sort of turned his head.

Well, father, I have been so interested in telling you about this "stunt" that I absolutely overlooked the fact that it was after 10 o'clock, and I ought to be in bed. Hazel wants to be remembered to both of you, especially mother. I think both of you will like her. I do. Affectionately your son,

Donny MacDougal.

THE UNITED STATES CIVIL SERVICE COMMISSION announces an examination for structural steel draftsman, for men only, on May 21 and 22, 1913, to secure eligibles to fill 2 vacancies in this position in the Bureau of Yards and Docks, Navy Department, Washington, D. C., at $4.72 a day. Competitors will be examined in the following subjects, which will have the relative weights indicated: 1. Mathematics (problems in mathematics and mechanics, involving a knowledge of arithmetic, algebra, geometry, and trigonometry, and including problems of moment of inertia, radius of gyration, and maximum bending moment and shear), 15; 2. Materials, details, and specifications (exercises in proportioning and detailing different parts of structures; knowledge of the properties of steel and iron and other important materials of construction; allowable unit stresses; specifications for materials and workmanship; and sketches of different details of construction), 15; 3. Drawing and design (computing strains and proportioning trusses, girders, etc., from given data and designing in outline structures to meet certain conditions; making complete working drawing from given data or from calculated stresses and sections; and tracing in ink from pencil drawings), 30; 4. Education, training,, experience, and fitness, 40. Applicants must have had not less than 6 years' suitable practical experience, of which not less than 2 years shall have been employed in office drafting. A technical education will be equivalent to 3 years of these 6. Age 18 years or over on the date of the examination. Persons who desire this examination should apply to the United States Civil Service Commission, Washington, D. C., for application and examination Form 1312. In applying for this examination the title "Structural Steel Draftsman (Male)," of this announcement should be used.

POWER PLANT CHEMISTRY

Classification of Coals, Method of Selecting Coal, Why Coals Burn with Short or Long Flame, Chemical Constituents of Volatile Matter

HAVING obtained the proximate analysis of coal as explained in the April 1 issue, we may then judge, to a great extent, the value of the coal and whether it will do for use in the furnaces under our boilers.

It is hardly necessary to state that the object of fuel in a power plant is to furnish heat. There are, however, conditions surrounding each plant which govern largely the kind of coal that can be used most economically. Two of these conditions are price for equivalent heating value and type of furnace. Disregarding local conditions, the following classification of coals given by Kent is a valuable aid to the engineer who is selecting coal:

CLASSIFICATION OF COALS

	Fixed Carbon	Volatile Matter	Heating Value per lb. Comb.	Relative Value of Combustible Semi. Bit =100
Anthracite	97 to 92.5	3 to 7.5	14,600 to 14,800	93
Semi-Anthracite	92.5 to 87.5	7.5 to 12.5	14,700 to 15,000	94
Semi-Bituminous	87.5 to 75	12.5 to 25	15,500 to 16,000	100
Bituminous East'n.	75 to 60	25 to 40	14,800 to 15,200	95
Bituminous West'n	60 to 50	35 to 50	13,500 to 14,800	90
Lignite	Under 50	Over 50	11,000 to 13,500	77

Using this as a guide in first selecting coal, varying from it only as local conditions prove advisable, would seem to be the most logical method of selecting coal. Then, by regularly analyzing the deliveries of coal and demanding coal of certain grades, conditions in the plant can be kept uniformly good.

In selecting coal for a particular furnace, it should be remembered that coal containing a large percentage of fixed carbon burns with a short flame; that is, when sufficient air is supplied to the burning carbon, the chemical change from carbon to carbon dioxide is rapid, so that the gases do not have time to travel far before they are completely consumed.

In the case of coal containing a large percentage of volatile matter, the reverse may be said to occur, that is, such coal burns with a long flame and requires considerable space and time for complete combustion due to the fact that the gas as liberated from the coal goes through changes before it is completely consumed, each change taking place under definite conditions of temperature and air supply. In order, then, to burn this class of coal in a furnace efficiently, it is necessary to provide plenty of combustion space so that the gases do not become chilled before complete oxidation can take place.

A reasonable amount of moisture in coal is not considered a great detriment, though, of course, it must be paid for and when the coal is burned this moisture it turned to steam which absorbs from the coal heat which is wasted up the chimney.

When purchasing coal, therefore, we are interested in keeping the percentage of moisture as low as possible. When speaking of moisture in coal, as determined by a proximate analysis, the chemist has reference to the uncombined water and not that which exists in combination with other elements to form compounds which are broken up at temperatures greater than 212 deg. F.

Ash, of course, is a waste and the less of it the better. Not only does it have to be paid for when the coal is purchased, but it must be removed from the plant and causes more or less trouble in keeping the fire clean and grates in condition for best combustion.

Sulphur, the percentage of which we do not ascertain by the proximate analysis, is a detrimental constituent of some coals, making them unavailable, in many cases, for power plant use. It exists usually in the form of iron pyrites (sulphide of iron, $Fe\ S_2$) though occasionally as sulphate of lime, but is always a detriment as it causes the fusion of the ash and forms clinkers. It has a slight heating value when in the form of iron pyrites, but as sulphate of lime it gives no heat. Usually, no particular difficulty will be experienced in using coal containing as high as 1.5 per cent, but over 3 per cent will practically prohibit its use. A method for determining the percentage of sulphur will be given in a future article.

Taking up in a more detailed manner the chemical constituents of the coal, we will begin with the volatile matter and are compelled to consider a rather complicated series of chemical compounds. Before we go further, it will be well to get a few chemical definitions well established in our minds.

Without going into technicalities, a molecule may be considered the smallest particle of any substance which can exist in the free state, and an atom is the smallest particle of matter which can take part in a chemical change. We may define an element as a substance whose molecules are composed of atoms of the same kind and therefore cannot be divided into 2 or more substances of different kinds. The compound has its molecules composed of atoms of different kinds, and may be broken up into elements.

The atomic weight of an element may be stated as the number of times heavier an atom of that element is than an atom of hydrogen, thus, an atom of hydrogen is taken as a unit for atomic weights.

The valency of an element is its combining capacity or a measure of its chemical affinity. For example, one atom of hydrogen unites with one atom of chlorine and when the reaction has taken place, the affinity between the 2 elements is satisfied, that is, one atom of chlorine will not combine with 2 atoms of hydrogen. But with the element oxygen, its affinity for hydrogen is not satisfied with one atom of hydrogen but requires 2, thus the valency of the element hydrogen is taken as unity, since its valency is the lowest of any known element, and that of all other elements is compared with it or an element of equal valency.

Such elements as hydrogen, chlorine, fluorine, and the like which have a valency of one, are called monovalent elements, while those whose atoms combine with 2, 3, or 4 atoms of hydrogen or other monovalent elements to form molecules of the compound, are called divalent, trivalent and tetravalent elements. It is a quality of many elements that their atoms will unite with other atoms in various proportions, according to the amounts present, their temperatures, pressure, etc., the valency or affinity of the atom not being entirely satisfied by the atoms of the other elements present.

For example, coal burned with an insufficient amount of air will form carbon monoxide (CO), there will most likely be also a percentage of CO_2, the proportion being determined quite definitely by the supply of air. Thus we see that while carbon is a tetravalent element, it may also become divalent under proper conditions.

Having gone briefly into a discussion of valency, we are in a position to understand more clearly what takes place when coal is heated in a retort with air excluded, forming what is known as volatile combustible matter.

Gases driven off (or distilled, as it is termed) at the lower heat of the furnace, are principally the hydrocarbons contained in the coal. The elements hydrogen and carbon combine in almost innumerable ratios, but may be separated into 3 series; methane (marsh gas) is the first member of one series, ethylene (olefiant gas) of another and acetylene that of the third.

Methane is found free in nature in large quantities in coal mines, not only in pockets and fissures in the coal veins, but also in the pores of the coal itself. It is composed of 1 part carbon and 4 parts hydrogen, the symbol being CH_4. The symbols of other gases of this series are found by multiplying the number of carbon atoms in the molecule by 2 and adding 2 atoms of hydrogen to the next lower in the series; the result being the atoms of hydrogen in the molecule, thus in this series we have ethane C_2H_6, propane C_3H_8, butane C_4H_{10}, etc. Methane is a colorless gas, having no taste or smell, it burns in air or oxygen with a feebly luminous flame. When mixed with air or oxygen and ignited, the mixture explodes with great violence. The products of complete combustion are water and carbon dioxide.

The second series of the hydrocarbon group begins with ethylene or commonly known as olefiant gas which has the chemical symbol C_2H_4, in this series the atoms of hydrogen are twice those of carbon, the symbols running C_2H_4, C_3H_6, C_4H_8, C_5H_{10}, etc.

Ethylene is a colorless gas having a somewhat pleasant ethereal odor, it burns with a highly luminous flame, forming carbon dioxide and water. When mixed with the proper proportion of oxygen and ignited, it explodes with great violence. Ethylene together with higher members of the series forms the principal illuminating constituent of coal gas.

The first member of the third hydrocarbon series is acetylene, the symbol being C_2H_2, the other members of the series have twice as many hydrogen atoms less 2, as there are carbon atoms, the symbols running C_2H_2, C_3H_4, C_4H_6, C_6H_{10}, C_7H_{12}, etc.

Acetylene is a colorless gas which has an extremely offensive odor and when inhaled will rapidly induce headache and in an undiluted state is poisonous. Acetylene burns with a highly luminous and smoky flame, but with specially constructed jets it gives a pure white light of great intensity.

The other volatile products of coal which are driven off by distillation are coal tar and ammoniacal liquor.

Coal tar is another hydrocarbon compound which, under proper temperature and air supply, will burn to carbon dioxide and water.

Ammoniacal liquor is ammonia gas dissolved in water, but by the action of the furnace heat the ammonia is driven off and with proper supply of air and application of heat it unites with oxygen.

A study of the constituents of the volatile matter shows that it will all burn in air with the production of heat and that the products of complete combustion are water and carbon dioxide (CO_2). Another important fact is that the volatile matter, under the comparatively low temperature of distillation or insufficient air supply precipitates free carbon which gives the gases a dark color and causes what is commonly called smoke, when this gas and free carbon have completely burned, however, the products, carbon dioxide and water vapor, are colorless.

The percentage of volatile combustible matter varies greatly with the quality of the coal, in fact coal is classified according to its percentage of volatile combustible and fixed carbon constituents.

After the volatile matter is driven off, the remainder is coke consisting of fixed carbon and ash. When this is burned the carbon unites with the oxygen in the air to form carbon dioxide (CO_2). Carbon and hydrogen are the principal heat producing elements contained in coal and in the next article of the series it is proposed to give methods for determining the amount of heat in coal both by means of experiment and by approximate formulas.

COOLING THE ENGINE BEARINGS

By Allen R. Kupfer

IN our plant the oil furnished was the cheapest grade that could be bought, consequently we had trouble all the time with hot boxes, journals or broken belts, particularly the engine bearings were hard to keep cool.

At last we solved the problem by taking a brass oil cup, drilling it with a 5/8-in. drill and making an aluminum pin with a V-shaped end. This pin ran on the engine journal and we used common mica axle grease which was supplied by the pin. We fixed the engine bearing trouble.

Dr. Charles W. Eliot, President Emeritus of Harvard, was the guest of honor at the annual banquet of the employes of the Simplex Wire and Cable Co., Boston. Dr. Eliot considered the profit-sharing plan originated by this company one of the best he had ever seen.

Dr. Eliot said that some plan of profit-sharing is the most effective method he has found for furnishing a motive of especial interest to employes. In spite of the fact that wages have steadily advanced and the hours of labor have decreased, this has not tended to bring about happiness and contentment among the laboring classes. There must be some additional motive back of all labor which will give a man an incentive to work, something in which he is vitally interested. He wants to look forward to something besides his regular daily wages. He wants a share in the profits he has helped to produce.

The profit-sharing system which the Simplex Co. has adopted has several interesting features. On the first day of each year a list of the names of those employes of the company who have been in continuous service for the previous 12 months is prepared. The men on this list are entitled to share in the profits of the company if they are still in its employ on the first of March.

The directors determine the percentage of the net profits that shall be appropriated to the profit-sharing system for each year. Extreme publicity of the affairs of the company is avoided and the company protects itself by a rule that it will not pay to one man over 20 per cent of his earnings. A table of dividends paid shows that these have been as high as 18 per cent of the men's earnings in 1906 and 1907 and as low as 9 per cent in 1910. Thus the size of the dividend depends on the success of the year's business.

This system has been given a thorough tryout. The share of each worker is in proportion to his pay. The men become interested in the results of their own labor as well as watchful in preventing the mistakes of fellow-laborers. Each one has an incentive to do his best work.

Dr. Eliot said that he believed that it is essential for the officials of any company to gain the confidence of their men before any such plan can be completely successful.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

OIL BURNING FURNACES

I HAVE noticed several articles describing various methods of burning fuel or crude oil, but have never seen anything resembling the method used in the plant where I am employed. To begin with we have 4 Heine water-tube boilers of 250 rated horsepower each, one of which must be out of service most of the time for cleaning on account of bad water, leaving only 3 boilers available for constant service. These must at times develop 200 per cent of rated capacity to handle the load, which occasionally drops to the normal rated capacity of boilers.

After trying out various furnaces and burners with various degrees of success, but still being unable to get the required amount of steam without making black smoke, we devised and installed the outfit shown in the accompanying sketch.

The burners are made of ¾-in. oil pipe enclosed in a 2-in. steam pipe, steam being used to heat, vaporize and atomize the oil during its passage through the heater-burner, which extends from front of ash pit back through it and up through openings in bridge-wall to a point about midway between the slightly lowered grate level and boiler tubes.

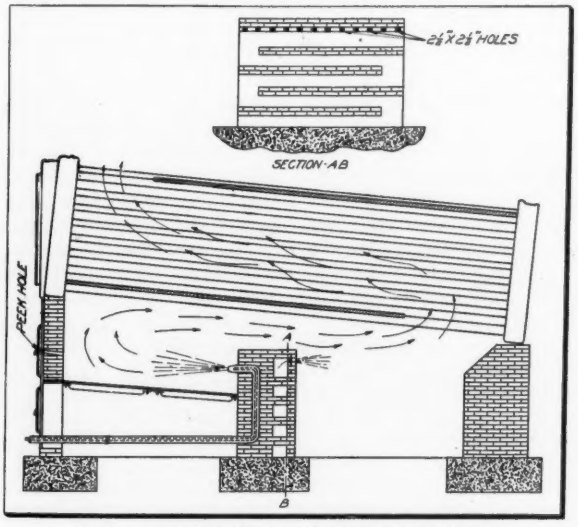


FIG. 1. SUCCESSFUL OIL BURNING FURNACE

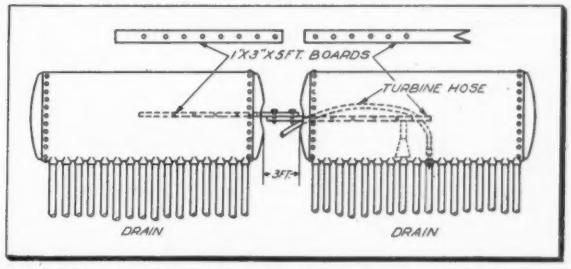
Steam gathers the vaporized oil as discharged from oil nozzle and hurls it toward the front of firebox where it meets a supply of air coming up through a 4 by 6-in. opening left in floor of firebox. This air, however, is not sufficient to produce complete combustion, therefore a secondary supply is afforded through the hollow bridge-wall shown in section AB, which is regulated by a hand damper.

The object in passing secondary air through bridge-wall as often as possible before releasing it, is to bring it to the highest possible temperature, thereby instead of cooling the gases coming over bridge-wall, it mixes with all unburned gases and causes more complete combustion.

We find also that it is possible to run with stack damper nearly closed which gives us a low flue gas velocity, and contributes largely toward a low stack temperature, high CO_2 and consequently a high efficiency at a heavy overload. B. M. Babcock.

BORING SCALE OUT OF BOILER TUBES

DIFFICULTY is sometimes encountered in boring scale out of the tubes of a vertical water-tube boiler and I have devised the following plan which works well in our plant. We have a battery of B. & W. boilers with the drum heads placed only 3 ft. apart which makes rather cramped working space and it is necessary to shut down 2 boilers when we wish to clean one. The scheme avoids the danger of a leaky stop valve when a man is in the boiler.



BORING OUT TUBES OF VERTICAL BOILER AND PLAN VIEW OF LEVER USED

Two boards 1 by 5 in., 5 ft, long are put together and drilled with ½-in. holes 6 in. apart; this makes a lever that can be extended to any desired length. A V notch is cut in the end of one board which serves as a holder for the turbine hose. A block may be nailed on the under side of the board at the desired distance from the end to serve as a fulcrum.

After entering the turbine in the tube it goes down with its own weight and to raise it we use the lever described, the end extending into the next boiler through the manhole. By this means it is not necessary for a man to enter the boiler drum.

E. Newman.

IMPROVISED GASKET

I ONCE had the experience of losing a cylinder head gasket and practically no rubber in the plant. A new gasket was made and worked for months, the material being a part of a breakfast food carton. The heavy paper used in these big boxes will hold on steam or hot-water end of a pump, also as a manhead gasket when you're caught short; use them on your cold water pump or in steam line on the heater plates

or doors when they require gaskets and if you will rub a bit of graphite over the faces, they can be taken off and replaced easily.

To use graphite to cover face of gasket, don't mix it with oil; wet with water if you wish, but don't use oil, as it rots the rubber.

In the March 1 issue Donald MacDougal tells how he made the mistake of not looking at the heads of the pump. He is not the first or the last one who will do it and don't forget there is another troublesome gasket in a pump; it is around the casing in the water end, so when your pump is in apparently first-class shape, yet falls down on the job of holding the water level, just take a look at this gasket.

Remove the studs holding casing into body of pump and tighten up the plunger; this will usually move the casing out so gasket can be examined. J. C. Lee.

COMMUTATOR AND DUPLEX PUMP TROUBLES

THE letter on slotting commutators by Joseph H. Unsworth in the February 15, 1913, issue of Practical Engineer was quite interesting to me particularly that part of it which refers to the use of a piece of sandpaper fastened to a block of wood, and used to smooth the surface of a commutator.

About one year ago I took charge of a plant which contained a 20-hp. motor, the commutator of which was badly worn causing the brushes to spark severely.

My predecessor had made a block of wood the same curvature as the commutator and with the piece of sandpaper fastened to it had tried to remedy the trouble, his object being, he told me, to cut the edges of the grooves on the commutator deeper in order that the brushes would rest evenly on the surface of the commutator.

I could see at the start that this was a useless task and as the condition was such that the commutator could not be taken out to be trued up in a lathe I had to find other means to stop the sparking.

The brush holders were constructed so that the brushes could wear nearly down to where the leads were connected before being renewed, and for this reason the brush holders were made about twice the thickness of a brush in order to let the lead connections pass through the holder.

I procured a piece of sheet carbon and made some brushes that practically filled the whole of the space within the holders, making them long enough so that they would wear a reasonable length of time before the lead connections, which are in the shape of a bar would strike the top of the brush holder.

When fitting these home-made brushes to the commutator I worked the sandpaper in a direction parallel with the commutator instead of in the direction of its circumference in order that the face of the brushes would fit the grooves in the commutator better. When the motor was started the sparking at the commutator had entirely disappeared, and the motor is still running with the same set of brushes and the commutator in the same condition. Since that time I have given the commutator an occasional application of commutator compound and a little light sandpapering, in fact I have less trouble with this motor than some of the others whose commutators are practically in good shape.

From observations of motors of the same type and horsepower in other factories I was at a loss to know at the start just how this trouble had been overcome.

There was considerable side play to the armature shaft of this motor, I also saw that there was no way of stopping it at that time.

I came to the conclusion that this side play simply threw the smaller brushes out of the grooves, and as they were a very poor fit, they had but little bearing surface on the commutator, and here too the motor was loaded to its fullest capacity which helped to increase the sparking. After the larger brushes were fitted to the commutator it had a tendency to run more central, and as the larger brushes, fitted in the manner which I have described, had more of their surface in contact with the commutator the sparking ceased entirely.

Should this commutator continue to run as well as it has for the past year, the chances are very slim of its ever being trued up unless some other trouble arises that will make it necessary to take out the armature.

In the same issue, Chas. Burns has an interesting article about some troubles he had with a duplex pump.

Troubles of this kind and the manner in which they are overcome should be kept in mind by those who have not had much experience in the operation of these pumps, for the time is likely to come when such knowledge will come in very handy.

I knew of a young engineer who took the examination for an engineer's license in a state where these examinations were rather stringent, and while he was fairly well posted in regard to engines, boilers, etc., he had but little knowledge of the duplex pump. He did not succeed in obtaining the license.

A few years ago I returned to a situation which I previously held for about 2 yr. When I left, things were in good running order, but upon my return I found one of the duplex pumps in very bad shape. This pump could not be operated except at a very high speed, as the piston rods were so badly worn on the water end that the shoulders caused by the wear would bind in the packing and cause the pump to stop.

This pump was used as an attemporator pump and in this case had to be kept in operation 24 hr. a day, which made it necessary to overcome the difficulty in some way. There was no spare pump at hand and as the owners refused to buy a new one, I overcame the trouble for the time being in the following manner.

The lost motion for the slide valve in this case was a fixed quantity, so I made liners out of pieces of tin and inserted them between the nut on the valve stem and the projections on the back of the valve. This shortened the stroke of the pump and by removing some of the packing from the stuffing boxes on the water end, the pump ran fairly well until the weather became cool enough to have the rods renewed.

Another time I had trouble with a duplex pump which short stroked on one side. Upon examination I found that one water cylinder was larger than the other, and as the night engineer had packed both pistons with the same size packing, the side on which the smaller cylinder was located short stroked.

Shortly afterwards these cylinders were bored out the same size and the trouble, of course, disappeared.

I have met engineers who considered such a thing as a duplex pump of secondary importance, but my opinion is that an engineer who thoroughly understands the principles which govern the operation of a duplex pump will be able to take care of such troubles as I have written of here which are submitted from time to time. W. S.

CORRECTION OF SLIDE RULE PROBLEM

I ENJOY working problems with the slide rule, and for practice I reviewed your pump example on page 325, March 15 issue. I wish to call your attention to several errors in this work.

$\frac{2{,}000{,}000}{24 \times 60 \times 100} = 13.888$, not 13.86. 13.89 is nearer and close enough for practical purposes.

Using 13.89 gal. gives a percentage a little better than 98.

(H) $\frac{9.72 \times 1000}{76{,}200 \times 13.86} = \$0.0092$, not \$0.092.

In 24 hr. 2,000,000 gal. at \$0.092 per M would cost \$184.00. You can readily see this is incorrect.

On page 326 a little past the middle of first column is given 112 deg.; no doubt this is a typographical error and should have been 212 deg.

John C. Brown.

A CRITICISM

ON page 192 of February 1 issue, under the heading (A Criticism), Mr. Dixon's letter is very educative, but I would question his answers to questions No. 11 and 12 and fear that his answers to these questions would not secure a second class engineer's license in Massachusetts.

If while shutting down a condensing engine the condenser should stop, what would you do?

I would turn the steam on the engine again, then cut out the condenser which should have been done before trying to shut down in the first place.

No. 12. If you had a condensing engine fully loaded and the condenser broke down what would you do?

When this occurs with a compound condensing engine we lengthen the cutoff on the low side as much as possible and give that side some live steam which does the trick until we can shut down and then set the exhaust valves to close a little later as it doesn't need so much compression when running noncondensing. Some run an engine with the governor block in and running below speed but it is dangerous practice and the point the inspector is trying to make when asking this question is whether or not you would resort to this practice in order to keep going.

A. W. Griswold.

METALLIC PACKING

IN reply to an inquiry by Thos. C. Robinson in Practical Engineer, page 188, February 1, I should say that I have used various kinds of soft packing and also many kinds of metallic packing for steam pressures up to 145 lb. pressure per square inch. I have used metallic packing on engines under various conditions, and have found, for similar conditions, as much as one-half difference in the lasting qualities of packing—one packing lasting almost one-half longer on one engine than on the other, and that the packing that lasted the longest wore piston rod the least.

This was in a plant having 2 450-hp., and 2 750-hp. engines. One kind of metallic packing was used on the 450-hp. engine, and another kind was used on the 750-hp. engine, with the results stated above. Soft packing was tried with unsatisfactory results on the above engine. These metallic packings were used on the piston rods only, as the soft, or fibrous packing was good on the Corliss valve stems. I have about decided that when the rods are large, a high rate of speed required and where steam pressure is medium or above, the metallic packing is the best.

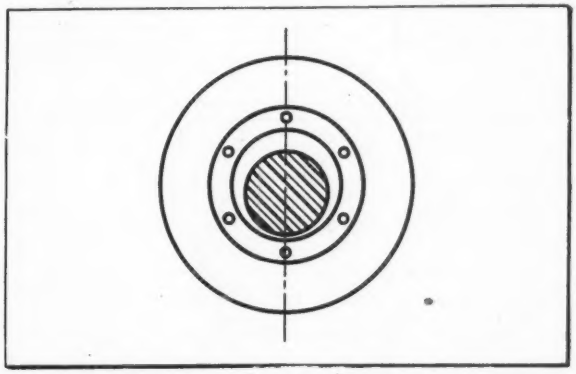
On small rods, or where steam pressure is low, or where travel in feet per second is small, I think the soft, or fibrous packing gives good satisfaction, that is, if you get a good kind and give it a fair show.

O. L. Harper.

METALLIC PACKING FOR ENGINE

I QUITE agree with Charles J. Mason about the metallic packing, although I have none on any of my pumps, yet I have been using them for the last 3 yr. on my mill engine, the size of which is 20 and 38 by 54 in., and runs at 64 r.p.m., and it is a tandem compound condensing engine.

As both the cylinders were not and are not in one level, it was giving us much trouble when we were using soft packing. High-pressure stuffing boxes would not be kept steam tight, and in the low-pressure



POSITION OF PISTON ROD IN STUFFING BOX

cylinder vacuum could not be maintained as high as desirable. If the packings were tightened any more, there would be an increase in the consumption of fuel, and the tightness of the stuffing boxes could only be maintained for a short time.

After fitting the metallic packings, with the same condition of the cylinder-level, there is no more trouble except the inspection and renewal (if any required) of the parts of the packing at an interval of a few months.

The illustration shows how the piston-rod is working in the low-pressure cylinder, yet there is no trouble.

N. N. Bava-adam.

WATER IN ASH PIT

LATELY I have formed the practice of putting water in the ashpit, ostensibly for the purpose of preventing the formation of clinkers, as the coal we are burning is high in ash and easily fusible, thus tending to choke the airspace in grate surface.

There being a closed feed-water heater in the plant, the water at the bottom of heater due to the condensation from exhaust steam, is piped to flow to the ashpit or is carried off into the sewer through a cross-connection when not needed.

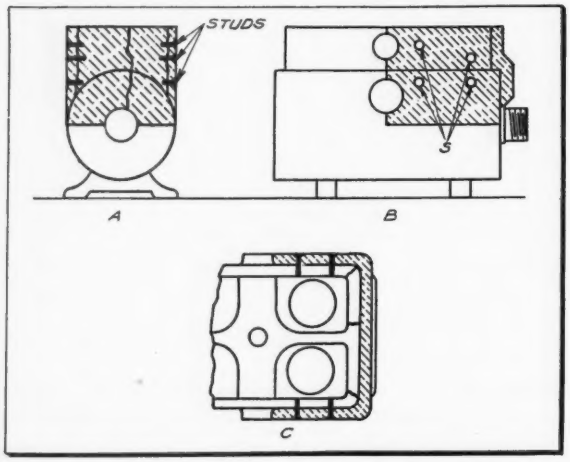
This arrangement of piping has averted to a large degree the formation of clinkers, which has been a troublesome question of long standing and necessitated cleaning the fires frequently. L. H. Danner.

Successful Kinks From The Plant

For Saving Time, Work and Trouble

Pump Repair Job

THE water end of the pump was left without draining and during a cold night it froze and burst as indicated by the irregular lines on the sketch. It was a feed pump and as a new one could not be obtained in time, the writer, being a machinist, was called upon to repair it if possible.



BROKEN WATER CYLINDER OF BOILER FEED PUMP AND REPAIR

Four studs were tapped into the sides as shown and the pump turned over to the brass foundry with instructions for the patch to be cast on the pump. The casting was done and returned to machine shop where the writer finished it and put the pump together. It was tested to 250 lb. cold water pressure and found to be perfectly tight. The pump was put into service in less than a day after it was broken.

R. B. Maguire.

Grounded Shunt Circuit

TROUBLE with a 200-kw. d.c. machine was caused by a monkey wrench in the hands of an oiler, who was engaged in tightening up the nuts on the switchboard, coming in contact with the nut and the sliding contact of the rheostat at the same time.

The oiler was comparatively unhurt but the shunt lead from the resistance box to the generator was burned off inside the box.

After repairs had been completed at this point it was found that the voltage would build up very slowly. On plugging in, however, on the double scale volt meter in opposition to the line voltage in order to parallel at zero, as is the custom, it was found that the small resistance thus created was sufficient to pull the voltage down to nothing, but when the plug was removed the voltage would build up slowly as before.

Although the polarity indicated all right on the volt meter, it was thought best to test for reversal polarity but without results.

At last a thorough test with a magneto revealed a ground in the shunt circuit which was discovered to be where the wire ran through the concrete floor into the conduit; the wire, which was lead covered cable, was grounded on the lead covering as well as on the concrete.

After this had been repaired it was found that the trouble had vanished. E. C. B.

Whistling Pump; Leaky Flange

I LIKE to go visting brother engineers, whenever I have the chance, because I always learn something that is well worth the time spent. I recently saw a little device on a sump pump that saves the man in charge a lot of trouble, and is simple. The pump in question is of the centrifugal type, driven by a small vertical engine, and set directly over the well, as space is limited, and the surplus water has to be pumped out almost continuously. The pump would often lose its

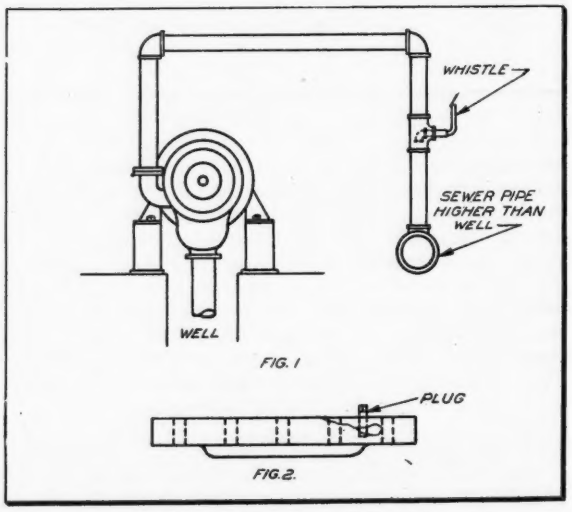


FIG. 1. WHISTLE ON PUMP LINE
FIG. 2. PLUGGING SAND HOLE IN FLANGE

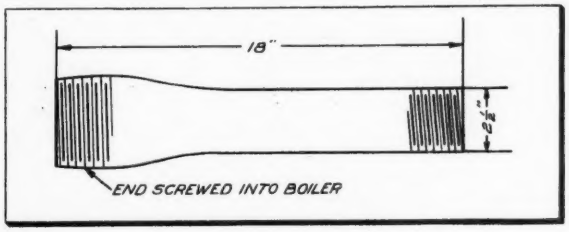
vacuum on acount of hot water, and as the place is rather noisy, the water would run on the floor. To overcome this, a small tin whistle was soldered to a ¼-in. nipple; this was screwed into a tee with a long thread on the inside, and an elbow placed on the inside; as long as the pump is working, the whistle is sounded, but as soon as the suction breaks, the whistle stops; it can be heard quite a distance from the pump. The whistle is of the small, flat type, such as used on peanut roasters; the sketch explains the arrangement.

In another plant I found the folowing: An 8-in. flange that connects the boiler yoke with the header,

gave trouble by leaking at the bolt holes. Different kinds of gaskets were tried, but the trouble continued. A corrugated copper gasket with asbestos rings was put in and the ⅝-in. studs pulled down as hard as they would stand; but after a few days the leak was there again. Now it was decided to replace the flange with another, but as it was screwed and beaded this was no easy job, so the surface was scraped clean and examined thoroughly, and the cause of all the trouble found to be a minute sand hole, which ran from the upper edge of the flange downward towards the bolt hole. By locating the direction of the hole, and drilling into it, the flange was found to have a hole in the center near a bolt hole. A ⅜-in. plug was screwed in and sawed off, and the flange gave no further trouble. R. Thiede.

Trouble with Feed-Water Piping

I HAD charge of a large power plant at one time, and had trouble with the feedwater eating out the feed-water piping and some of the boiler plates. Where the feed-water pipe entered, the boilers became cut and eaten so badly that it was impossible to stop them from leaking around the pipe. The pipe, where it entered the boilers, was double strength, 2½ in. in diameter. New pipes were cut and threaded and the hole in the boiler sheet was tapped out until the hole



IMPROVED EXPANSION NIPPLE

was too large for the standard size double strength pipe, and it was so close to a seam in the boiler drum that it was not practical to ream out and tap the hole for 3-in. pipe; so I ran a 2½-in. pipe tap through the sheet and then took a piece of double strength pipe and had the backsmith upset the end while heated until the pipe was somewhat larger than standard, then we opened up the pipe machine to cut a good thread, and threaded the pipe where it was enlarged. Then the pipe was screwed into place and proved to be a good job. O. L. Harper.

Handy Windlass; Expansion Bolt

HERE is a kink that I have often found useful when I was alone and wished to move some large body that was too heavy for my strength. It is called a Spanish windlass, and was invented (So I was told, by the old civil engineer who showed it to me) by the South American Indians and was commonly used by them to haul their boats onto the bank of the stream or rivers.

The necessary material to make this windlass is first, a strong rope, second, 2 crowbars or wooden levers (I have used 1¼-in. steam pipe), third, an immovable post or solid anchorage to which one end of the rope can be made fast.

Now hitch the other end to the object to be moved, leaving just slack enough to get a twist around one of the levers as shown at A. Next, take the other lever or bar, and placing one end on the ground or floor let the middle part of it set into the corner formed by the intersection of the twisting lever and the rope, as shown at B. Now, by sweeping the long end of the first lever in a horizontal plane and in the direction shown by the arrows, one man can, with a 4-ft. lever, exert strain enough to drag ½ ton on a floor or hard ground and not work hard either. I have often moved 2 tons on rolls or a wagon. If one gets tired or if

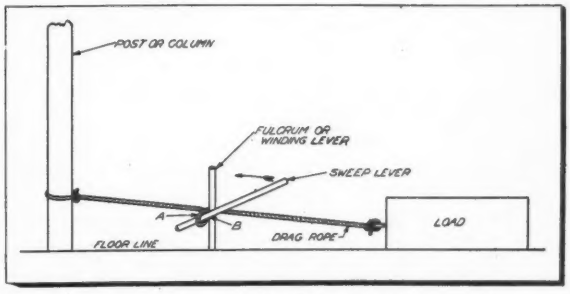


FIG. 1. A HANDY WINDLASS

alone and wishes to drop the sweep for any reason, all that is necessary is to bring the sweep parallel with the drag line and bind or strap it there and in this way avoid doing a lot of twisting a second time. This isn't very fancy but is worth knowing and will often save a long wait for chain falls, etc., and save many a back ache besides.

I was at one time several miles from a hardware store and found that I needed some expansion bolts in order to complete some repairs to the plant in which I was working. It would take at least 2 days

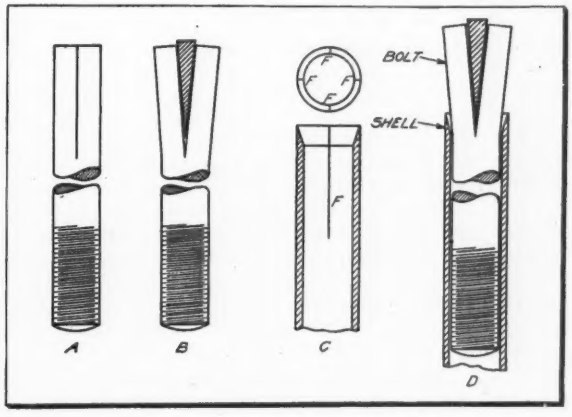


FIG. 2. IMPROVISED EXPANSION BOLT

to send out for what I needed and the boss wanted to start up as soon as possible, as time meant money at that season. This is how I got by: I found some ⅝-in. bolts the desired length and cut off the heads. Then with a hacksaw, I cut a slot 1½ or 2 in. in length and next I spread the ends and drove in some iron wedges, as shown in sketch Fig. 2A. I then sawed off some pieces of ¾-in. pipe the proper length, and with a round file I chamfered the inner edge of 1 end, then sawed 2 slots at right angles to each other in the same end. I next heated this end of the pipes a bright cherry, and covered them with air slacked lime till cool and my expansion bolts were ready for installation. I found them fully as good as any I could have bought. W. E. Chandler.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Boiler Setting

WILL you kindly advise us what you consider to be the best setting for a horizontal return tubular boiler 78 in. by 18 ft., designed to carry 150 lb. pressure, and to burn soft coal? What we desire specially is the best distance to place boiler above the grates, and also the distance from the boiler shell to bottom of combustion chamber, and from the back head to the rear wall of the setting. This boiler has 84 4-in. tubes, and we desire to obtain the best possible setting for coal economy, accompanied with good steaming qualities. W. M. C.

A. For a plain horizontal return tubular setting combining economy and capacity a 78-in. by 18-ft. boiler should be set 32 in. from the dead plate to shell with a 24-in. ash-pit, making 56 in. from the floor line to the boiler. The grates can be 6 ft. long and 6 ft. 6 in. wide with advantage and can pitch 4 in. to the bridge wall, making a total height from the grate to the boiler at the bridge wall of 36 in. The bridge wall should be 18 in. high, giving 18 in. in the clear between the bridge wall and shell. No filling should be allowed in the combustion chamber; it should be excavated to level with the boiler-room floor, giving 56 in. from the combustion-chamber floor to the boiler shell. A good, substantial fire brick pier should protect the blow-off pipe, and a distance of 32 in. should be allowed between the back head of the boiler and the back wall of the setting under the skeleton arch.

The damper should have a free opening of 25 per cent in excess of the combined area of the tubes and should be 18 in. wide if possible and in any event not less than 16 in. wide. In other words, the damper should not be long and narrow but should be as near rectangular as possible.

A draft of 0.5 in. at the damper is advisable if it can be obtained; this will give 0.25 in. draft over the fire and will give opportunity for getting very satisfactory capacities out of the boiler.

It must be understood that this setting is strictly for economical steaming and bears no reference to smoke suppression.

Reinforcement of Boiler Openings

WHERE are manholes, handholes and pipe connections reinforced? C. E.

A. Manholes and handholes are reinforced by 1 of 2 ways. One way is that a ring of boiler steel is formed to fit the shell or head on the inside around the part cut out, and is riveted thereto by 1 or 2 rows of rivets. The ring being designed with suitable width for this purpose, and to give this section as nearly as possible the strength of the solid plate. The other method that is used especially on water-tube boilers is to form an inside projecting flange of the metal around the hole. The edge of this flange is turned smooth, and forms a seat for the gasket under the plate.

Pipe connections are sometimes reinforced by a ring riveted to the shell around the hole on the inside and the threads cut through both the shell and ring. For large pipes, especially steam pipe and safety-valve outlets, a throat piece is so constructed that it fits the curvature of the shell to which it is riveted, and the other end has a flange of the standard pipe flange size, to which the steam pipe or safety valve is bolted with a gasket between the flanges. In some special cases the reinforcing ring is welded to the shell or head around the opening.

Systems of Forced Draft

WHAT are the principal forced and, induced draft systems; their advantages, and disadvantages? F. E.

A. Mechanical draft is divided into 2 systems, according to whether the air is caused to enter the furnace by reducing the pressure at some point between the boiler and smokestack so as to make it less than atmospheric pressure, or whether the air is forced into the furnace under a pressure slightly greater than atmospheric pressure. The former method is called induced draft, and the latter forced draft. The same kind of a fan is used for both systems. The advantages claimed for the induced draft system are (1) Low first cost. (2) No necessity for a tall chimney, unless required to carry the smoke and gases above neighboring buildings. (3) Control of draft. (4) Uniform combustion. (5) Leakage inward. No dust or hot gases blown out into the boiler room. (6) Adaptability to use with economizers.

Disadvantages. (1) The high temperature at which the fans must run due to the fact that they are located in the breeching and are constantly surrounded by the gases at a temperature ranging from 600 to 1000 deg. F. (2) Expense of operating. (3) Water required to cool the bearings.

There are 2 methods of installing forced draft, First; by making the fire room or "stoke hole" air tight, and creating therein by means of a fan or blower, an air pressure greater than atmospheric pressure. Used principally on shipboard. Second, by closing the ash-pit air tight and creating an air pressure therein, greater than that of the atmosphere. Used in stationary plants.

Advantages of closed ash-pit system are: (1) Small volume of air to be handled, due to low temperature of air used. (2) Small first cost of apparatus. (3) No danger of overheating the bearings.

Disadvantages are: (1) Necessity of a chimney of sufficient height to overcome all resistance to flow of gases through the different flues and out of the chimney. (2) Less flexibility, and less control of draft. (3) Not adapted for use with fuel economizer. (4) Leakage of air outward into boiler room. (5) Difficulty of controlling the fire.

Refrigeration Problem

WE have a small ice plant with a simple, double-acting, 9 by 12-in. compressor and 12 by 15 by 8-ft. ice storage room cooled by ammonia pipes. We want to add a 15 by 30 by 8-ft. ice storage room and install a brine cooling system for both rooms. What length and size of pipe will be required, and what size brine pump should we install? W. H. P

A. In regard to the enlargement to your ice storage, the room 15 by 30 by 8 ft., would have a cubic contents of 3600 cu. ft., and would probably store about 72 tons if filled completely. This should be maintained at a temperature of some 20 deg. F., and that for a brine circulating system would call for about 300 ft. of 2-in. pipe, 420 ft. of 1¼-in. pipe or 540 ft. of 1-in pipe. This should, of course, be placed on the ceiling. To take care of this space will call for about 1½ tons refrigeration capacity, and will need a brine tank of some 90 cu. ft. capacity, carrying 180 ft. of 2-in expansion pipe. We give you these figures so that you may check up to see whether your present brine tank and expansion coils are sufficient for the extra load.

The brine pump should have a capacity of about 6 gal. a minute, which at 60 strokes would call for a 3 by 3 single cylinder, or a 2¼ by 3 duplex on the pump end. A. L. R.

Double Eccentric Engine; Butt Joint

WHAT are the advantages of 2 eccentrics on a Corliss engine and why?

2. Please explain how to figure a butt joint. W. S. D.

A. The object of 2 eccentrics on a Corliss engine is to provide a means for setting the exhaust and admission valves separately.

2. Below you will find the method for figuring the strength of a butt joint:

T. S. = tensile strength of plate, in pounds per square inch.
t = thickness of plate, in inches.
b = thickness of butt strap in inches.
P = pitch of rivets, in inches, on row having greatest pitch.
d = diameter of rivet after driving, in inches.
a = cross-sectional area of rivet after driving, in square inches.
s = strength of rivet in single shear, iron rivets, 38,000 lb., steel rivets, 42,000 lb.
S = strength of rivet in double shear, iron rivets, 70,000 lb., steel rivets, 78,000 lb.
c = crushing strength of mild steel, taken as 95,000 lb. per sq. in. cross-sectional area.
n = number of rivets in single shear in a unit of length of joint.
N = number of rivets in double shear in a unit of length of joint.

Butt and double strap joint, double riveted.

A = Strength of solid plate = $P \times t \times T.S.$
B = Strength of plate between rivet holes in the outer row = $(P - d)\ t \times T.S.$
C = Shearing strength of 2 rivets in double shear, plus the shearing strength of 1 rivet in single shear = $N \times S \times a + n \times s \times a$.
D = Strength of plate between rivet holes in the second row, plus the shearing strength of 1 rivet in single shear in the outer row = $(P - 2d)\ t \times T.S. + n \times s \times a$.
E = Strength of plate between rivet holes in the second row, plus the crushing strength of butt strap in front of 1 rivet in the outer row = $(P - 2d)\ t \times T.S. + d \times b \times c$.
F = Crushing strength of plate in front of 2 rivets, plus the crushing strength of butt strap in front of 1 rivet = $N \times d \times t \times c + n \times d \times b \times c$.

Divide B, C, D, E, F, (whichever is the least) by A, and the quotient will be the efficiency of a butt and double strap joint, double-riveted.

T.S. = 55,000 lb. a = 0.6013 sq. in.
t = ⅜ in. = 0.375 in. s = 42,000 lb.
b = 5/16 in. = 0.3125 in. S = 78,000 lb.
P = 4⅞ in. = 4.875 in. c = 95,000 lb.
d = ⅞ in. = 0.875 in.

Number of rivets in single shear in a unit of length of joint = 1.

Number of rivets in double shear in a unit of length of joint = 2.

$A = 4.875 \times 0.375 \times 55{,}000 = 100{,}547.$

$B = (4.875 - 0.875)\ 0.375 \times 55{,}000 = 82{,}500.$

$C = 2 \times 78{,}000 \times 0.6013 + 1 \times 42{,}000 \times 0.6013 = 119{,}057.$

$D = (4.875 - 2 \times 0.875)\ 0.375 \times 55{,}000 + 1 \times 42{,}000 \times 0.6013 = 89{,}708.$

$E = (4.875 - 2 \times 0.875)\ 0.375 \times 55{,}000 + 0.875 \times 0.3125 \times 95{,}000 = 90{,}429.$

$F = 2 \times 0.875 \times 0.375 \times 95{,}000 + 0.875 \times 0.3125 \times 95{,}000 = 88{,}320.$

$$\frac{82{,}500\ (B)}{100{,}547\ (A)} = 0.820, \text{ Efficiency of joint.}$$

N. G. M.

Hydraulic Elevator

KINDLY explain a hydraulic elevator system; open and closed tanks. E. L. T.

A. The power producing mechanism of a hydraulic elevator consists of a cylinder and piston, the piston being connected by a rod, or rods to a crosshead which carries suitable sheaves over which runs a system of lifting cables from which the car is suspended. By means of suitable valves, and controlling mechanism operated from the car, water under pressure, either from compression, gravity tank systems, or from street mains where sufficient pressure is available, is caused to flow into, and out of the cylinder, thus causing the piston to move from one end of the cylinder to the other, and back again.

This motion of the piston and crosshead to and fro imparts motion to the lifting cables which pass over sheaves at the top of the elevator hatchway, and which hold in suspension the car, thus moving it up or down, according as the water flows into, or out of the water cylinder. The motion of the piston transmitted to the cable is multiplied to a greater, or less degree by passing the cable over sheaves designed for the purpose.

In the open tank system the water pressure averages about 150 lb. per sq. in., requiring large size water cylinders, the diameter being 16 in. or more, with a 6-in. supply pipe, while with the closed tank system in which the water pressure is 700 or 800 lb. per sq. in., a water cylinder 6 in. in diameter having a 2-in. supply pipe would exert as much lifting power as would the 16-in. cylinder with 125 lb. pressure.

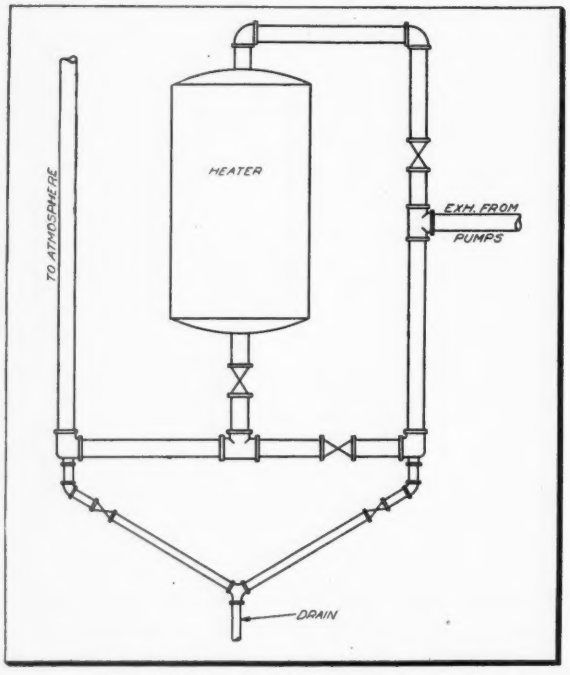
Remedy Desired for High Voltage

I HAVE a transmission line which has a higher voltage at the distributing end than at the generating end. This line is 1¼ miles long, 3-phase, 2200 v., 25 cycles. This line supplies current for a 200-kw., shunt-wound rotary converter, stepping the a.c. voltage down from 2200 to 378 v. through transformers, giving 600 v. d.c. While having 2200 v. at the power house we have as high as 2700 v. at the other end.

We cannot use the field regulating rheostat on the rotary as the voltage is too high the way it is and without using the rheostat we get a power factor of 95 per cent lagging. Can any of you readers tell me how I can remedy this trouble? O. E.

Heater Piping

TO A. J. who presented a problem in heater piping to readers of Practical Engineer I should suggest



HEATER PIPING SUGGESTED BY A. J. S.

that the connections be made as shown in the accompanying sketch. A. J. S.

Armature Winding Problem

I HAVE a problem upon which I would be glad to have the opinion of some of the readers of Practical Engineer.

We have an old bipole link belt mine locomotive that has been standing on the side track for some time. A short time ago the mine superintendent asked if I could put this locomotive in working order. I pushed the old relic into the shop and started to work. I lifted the top magnet and pulled the armature out and found that it needed to be rewound. I lifted the old coils and rewound the armature, put it in and tried it out. The result was the arm conductors broke off one after another just back of the commutator. I pulled it out and rewound it again, this time I soldered flexible leads on the end of the coils, and it ran about 4 hr. then threw the solder from the commutator and the armature conductors were hot enough to burn the slot insulation and grounded the coils. The flexible broke off the same as the solid did. I examined the field magnets and found them all good and running cool.

Winding data: 500 volts series wound motor; 60 commutator bars, 60 coils; winding pitch 1 and 31, 3 turns per coil; coils connect to commutator segments 1 and 2, 2 and 3, 3 and 4, etc.; size of wire No. 8 B. & S. d. c. c.

The field magnets are wound with No. 2 d. c. c. J. A. D.

Handling the Boiler

IN reply to Subscriber's question in your Mar. 15 issue of Practical Engineer, cutting in and cutting out a boiler is some of the most important work in a boiler plant, and a man can never be too careful when doing it.

When cutting out a boiler set in a battery, be sure that the brickwork is cooled off enough so it will not raise the pressure after boiler is cut out. Lower the steam pressure as much as possible before cutting the boiler out. Do not open any doors or dampers in order to cool boiler off, if you are not in a hurry, as that may cause leaks in tubes and rivets.

Rear heads are flanged in and front heads out to get a chance to calk the joints. Boilers are made that have both heads flanged in; in that case we have to have light brickwork to take care of the gases as they leave the tubes.

The idea of banking a fire in case of low water is not so much to lower the pressure as it is to prevent the heat from striking the tubes or other parts of the boiler.

You certainly are right about the manhole plate; always bear in mind that a manhole plate on a boiler with 60 lb. of pressure, has 75 lb. absolute pressure on each square inch. Example: a manhole plate 11 by 15 in. contains $15 \times 11 \times 0.7854 = 129$, area of plate in square inches; 75 lb. multiplied by 129 gives 9675 lb. pressure minus the weight of the plate itself; in other words, that is the weight necessary to push the plate in.

As a matter of fact, I have been firing a boiler across the Atlantic with the manhole plate dogs and nuts loose; we did not tighten them up as it was unnecessary, besides I prefer not to use a wrench on any part of the boiler with pressure on. C. M.

THE GREATEST DIFFERENCE IN ELEVATION of land in the United States, according to the U. S. Geological Survey, is 14,777 ft. The highest point is Mt. Whitney, 14,501 ft. above sea level, and the lowest point is Death Valley, 276 ft. below sea level. The 2 points, both being in California, are less than 90 miles apart. This difference is, however, small compared with the figures for Asia. Mt. Everest stands 29,002 ft. above sea level, while the shore of the Dead Sea is 1290 ft. below sea level, giving a total difference in heights of 30,292 ft.

The greatest ocean depth yet found is about 40 miles north of Mindanao, in the Philippine Islands, and is 32,088 ft., so that at this point the ocean bottom is 11½ miles below the summit of Mt. Everest.

SO LONG AS there is work to do there will be interruptions—breaks in its progress—And it is a part of one's character growth to bear these timely or untimely interruptions without any break in good temper or courtesy.

Heater Piping

IN answer to A. J.'s National Heater Problem, in March 1 issue, I would put an exhaust valve in pipe to atmosphere on the atmosphere side of the tee where the by-pass enters, then open the by-pass, shut the large bottom gate valve and open drips enough to keep the heater and pipe clear of water and go ahead.

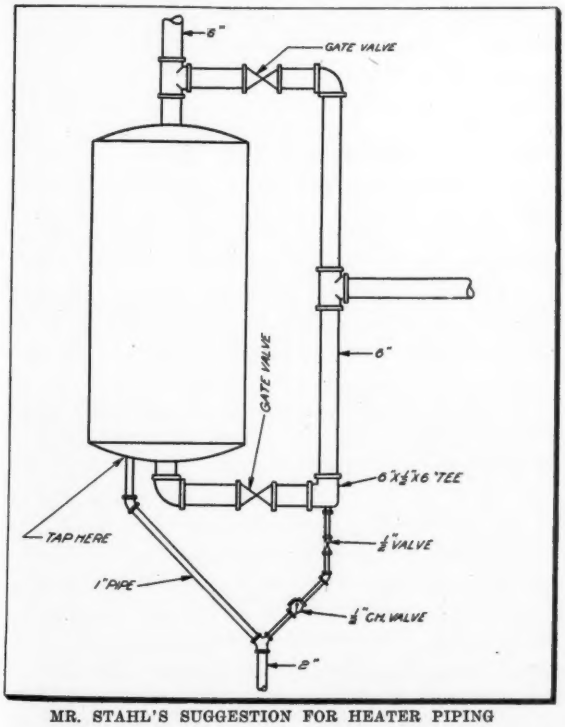
I operate a large closed heater that takes care of 1000 hp. in engines fully loaded, this heater absorbs all the steam of the engines and is piped as above. I do not approve of the plan of piping into center of heads with the large pipe; they could just as well be piped in at the side, which would leave the heads free to be taken off to clean heater.

The coils and tubes of a closed heater become covered with a slimy, sticky mess of cylinder oil that steam does not seem to remove. I clean the heater once a year by filling the exhaust steam space full of water and putting in concentrated lye or boiler compound of a soda nature and boiling it for about 1 hr.; then thoroughly wash the heater.

The writer started a closed live steam heater used to heat water for hot water heating; the heater refused to heat and I found that oil used by pipe fitters in cutting pipe had coated the inside steam tubes so that they would not conduct heat. One hour's application of lye entirely removed the trouble. F. G.

Heater Piping

REFERRING to A. J.'s heater problem on page 286, March 1 issue of Practical Engineer, I submit a sketch. If he puts a 6 by ½ by 6-in. tee and a ½-in. check in main line I think the difficulty will be overcome. When in full operation there is a tendency to create a vacuum, and this would stop it.



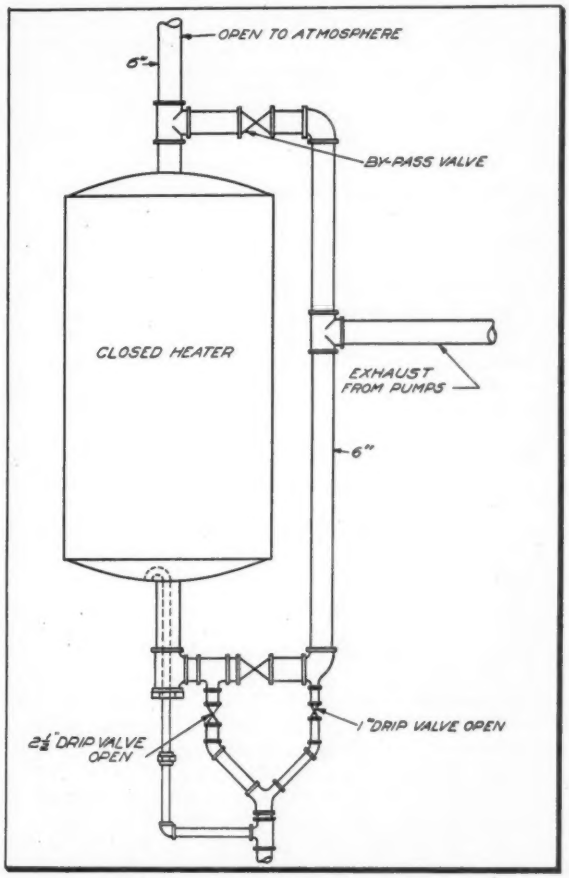
MR. STAHL'S SUGGESTION FOR HEATER PIPING

Now, where the most condensation takes place would be in the heater and I would advise as you see in the sketch tapping for a 1-in. pipe, and I know that would drain the heater. C. H. Stahl.

Heater Problem

IN the Mar. 1 issue of Practical Engineer, on page 286, A. J. asks for sugestions for removing condensate from his closed heater. I believe that the difficulty is due to velocity of the steam in the pipe entering the bottom of the heater, since he says that trouble occurs at full load.

I would suggest an independent drain in the bottom, but if for any reason another hole cannot be made, change the ell below the heater to a tee and close the bottom opening of the tee with a plug tapped for a 1-in. pipe.



PROPOSED CHANGES IN HEATER PIPING

Cut a piece of 1-in. pipe with running thread on lower end and bend the end to form a siphon with small enough radius to let it into the 6-in. pipe. Pass the bent end through the tee and hook the end over the end of the steam pipe and let the short end come close to the bottom of the heater. Before connecting the pump discharge into the tee, screw the running thread of the 1-in. pipe into the hole tapped in the plug in a manner to allow a pipe sleeve to connect below the plug which is connected to the drain. Pressure of steam in heater will force water out of the heater through the 1-in. drain pipe, and when the water is once in the pipe the siphon will work continuously. The new arrangement of piping is shown in the figure. Chas. M. Green.

THE BEST EXECUTIVE is the man who gets all the suggestions he can from his employes, and adopts those that seem to him wise.

PRACTICAL ENGINEER

Trade-mark reg. U. S. Pat. Office.

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH
At 537 So. Dearborn Street, Chicago, Ill., by the
TECHNICAL PUBLISHING CO.

New York, 150 Nassau St. Cleveland, Am. Trust Bldg.

Notify us at once of any change of address, giving the old and the new address, so that your paper may always reach you promptly.

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Entered as second class matter May 1, 1908, at the Post Office at Chicago, Illinois, under the Act of March 3, 1879.
Circulation of this issue, 23,500.

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EDUCATION AND SKILL

The following paragraph appeared in one of our magazines which is published for young men.

"There is no place in the modern world for the unskilled; no one can hope for any genuine success who fails to give himself the most thorough technical preparation, the most complete special education. Good intentions go for nothing and industry is thrown away if one cannot infuse a high degree of skill into his work. The man of medium skill depends upon fortunate conditions for success; he cannot command it nor can he keep it. The trained man has all the advantages on his side; the untrained man invites all the tragic possibilities of failure."

There never was a time in history when this was truer than now. There is no class of men of whom it is truer than power plant engineers. The engineer who is trained is the one who succeeds.

This may appear discouraging to some engineers "who have not had the opportunity to get an education." It should not be so, for there is still a chance for any man who means business. Too many men get scared at the word "education" and seem to think that it is something beyond their approach.

The dictionary gives the following meaning of the words "education" and "skill":

Education—instruction; formation of manners.

Skill—familiar knowledge united to readiness of performance.

So the thing is not so complex after all. Generally there is only one thing which will prevent a man's becoming educated and skillful in his own particular line. This one thing is the lack of ambition. If a man does not have sufficient ambition he is not apt to get an education. If he has the ambition he will get it or "bust something" in the effort. He will not look to others to educate him; he will educate himself.

As the man who attends college carries perhaps a half dozen subjects, so there are a half dozen methods which the engineer should follow in order to educate himself:

The first is, study. If a man has not been accustomed to study, he will, of course, have to accustom himself gradually to learn to study, to think, to memorize. One should not only study books, formulas, etc., but should also study methods and men. He should make a study of his occupation.

Second, reading; the reading of technical magazines and periodicals devoted to the profession for which he is endeavoring to fit himself. Reading, with the conditions of his own plant in mind, if perhaps he may not be able to find something that will be of immediate help to him in his present job. Reading, not necessarily "to swallow everything" he reads, but to get other men's opinions and experience and thus be better able to form his own. Many men say "I haven't time to

study or read. I have to work." Every time you have ten minutes, take advantage of it. Your brain can do just so much work in ten minutes and you will be just that much ahead.

Third, observation; learn to "see things." Not only with your eyes, but with your brain as well. Observe the methods of others. Study them and see whether they be good or bad, apply the good and reject the bad.

Fourth, experimentation; if you have the idea that certain causes will produce certain effects, that certain changes in equipment or method will produce higher economy, experiment and find out. Don't wait for the other fellow.

Fifth, experience or practice; without this, one cannot hope to be a successful engineer. Don't be satisfied with the same experience forever. A man may boast of having twenty-five years' experience as a fireman and yet he may be no better fireman than he was at the end of the first year. After you have mastered one thing, hunt for a new experience.

Sixth, System: Corporations, factories and business houses of all kinds have found that they could raise their efficiency several per cent by having an expert to systematize their business. This is not only true of the business house, but also of the power plant. For the highest efficiency, there must be a system to which every part of the work, and every man on the job has a definite relation. Not only is this true of the plant as a whole but also of the individual. If he is to be successful, he must have a system of his own, not only with regard to his work but with regard to his personal habits, also. A time to rise in the morning, a time to eat, exercise, study, read, etc. "Well arranged time is the surest evidence of a well arranged mind."

NEWS NOTES

UNITED STATES CIVIL SERVICE Commission announces an open examination for architectural and structural steel draftsman, for men only, on May 7 and 8, 1913, at principal cities of the country. From the register of eligibles resulting from this examination certification will be made to fill vacancies as they may occur in this position in the Lighthouse Service, at a maximum salary of $1500 a year, and vacancies requiring similar qualifications as they may occur in any branch of the service, unless it is found to be in the interest of the service to fill any vacancy by reinstatement, transfer, or promotion.

Competitors will be examined in the following subjects, which will have the relative weights indicated:

1. Mathematics, pure and applied	20
2. Topographical and hydrographical surveying.	15
3. General building and steel construction and drawing	40
4. Training, experience, and fitness	25
Total	100

Five years' experience in engineering work or drafting is a prerequisite to eligibility for appointment from this examination; of these 5 years a technical school training will be considered equivalent to 3 years.

Persons who meet the requirements and desire this examination should at once apply to the United States Civil Service Commission, Washington, D. C., or to the secretary of the board of examiners at principal cities of the country for application and examination Form 1312. No application will be accepted unless properly executed and filed with the Commission at Washington. In applying for the examination the exact title, Architectural and Structural Steel Draftsman (male), should be used.

T. T. BURCHFIELD, OF THE T. T. Burchfield Co., has assumed the Philadelphia agency of A. L. Ide & Sons at 54 N. 6th St.

THE HOOVEN, OWENS, RENTSCHLER Co., of Hamilton, O., announces that, while its works were slightly flooded, it is now back to normal operating conditions and can take care of shipments of engines, etc., with its usual promptness.

WORD COMES from the Dean Bros. Steam Pump Works, Indianapolis, Ind., that its plant was not affected in any way by the recent flood. While there will be some disarrangement of shipping facilities, such hindrance will probably be removed by the time this appears in print.

AUGUST 25 TO 30 the Fourth International Congress on School Hygiene will be held in Buffalo, N. Y. A comprehensive program of papers and discussions will be arranged, with exhibits of the best that is now being done in school hygiene, including the work with the pupils themselves and the mechanical equipment of the plant.

GEORGE M. HARDEN, for a number of years treasurer of The Philadelphia Pipe Bending Co., Philadelphia, has resigned his position with that company and will continue in the same line as district sales agent of The Whitlock Coil Co., Hartford, Conn. He has established offices at 518 Drexel Building, Philadelphia, for the sale of the various products of this company, which include coils or bends of pipe or tubing in iron, steel, brass and copper.

OFFICERS OF THE American Pulley Co., were hosts at a banquet held at the Germantown Cricket Club of Philadelphia on April 1. C. A. Brinley, president of the company, gave a gratifying report regarding the Employes' Benefit Fund, which is now being set aside, and plans were discussed looking to the greater development of the company. In all discussion, the welfare of the men, who have helped make the company, was considered. Horace Sheble, an expert on efficiency, gave an interesting talk on methods to be pursued.

CHANGES IN THE MEMBERS of the firm of H. B. Underwood & Co., 1025 Hamilton St., Philadelphia, Pa., are announced, Morris G. Condon having purchased his partners' interests in that firm. The business of engine repairs and general machine work will be continued at the same address and under the same firm name, the men connected with the firm being, M. G. Condon, David C. Hitchner, Hiram D. Griffith, and Chas. O. Ralph.

IN A LETTER from The Hoppes Manufacturing Co., of Springfield, Ohio, the president, John J. Hoppes, makes the following statements:

Press reports which have indicated that Springfield was wiped off the map by the recent flood, or that the city was greatly damaged and manufacturers put out of business, are in error, as none of the manufacturers were injured, and the only damage was to a few inferior dwellings. There was no loss of life.

There has, of course, been inconvenience from lack of railway facilities, because of the washing away of bridges. But Springfield has been busily engaged in relief work by money contributions and personal assistance to the afflicted cities in Ohio, and all factories are running and the city is in prosperous condition.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

NEW ENGINE FOR PAPER MILLS

Suitable for Any Plant Where Wide Speed Variation is Required and Careful Balancing Desirable

FUNDAMENTAL requirements of a paper mill engine are a speed range equivalent to that desired for the rolls, and as near as possible, perfect regulation at all speeds.

The secret of engine design for wide speed range is to arrange the cylinders of the engine and to design reciprocating parts and counterweights so that the reciprocating forces are neutralized and perfect balance is secured thus permitting of running the engine at high speeds.

cating forces from a horizontal to a vertical plane, in which they meet equal and opposite reciprocating forces from the vertical reciprocating masses, which therefore neutralize unbalancing.

This balancing is such that the engine may be operated at speeds of 400 to 500 r.p.m., and even turning effort permits operation at a lower speed of 50 r.p.m. with good regulation so that a total speed range of 8 to 1 and even 10 to 1 may be obtained, so that engine may be coupled directly to the line shafting.

Figure 2 shows the American-Ball patent flexible coupling for paper mill engine drive. This is a coupling with a lacing of belt, but the lacing does not

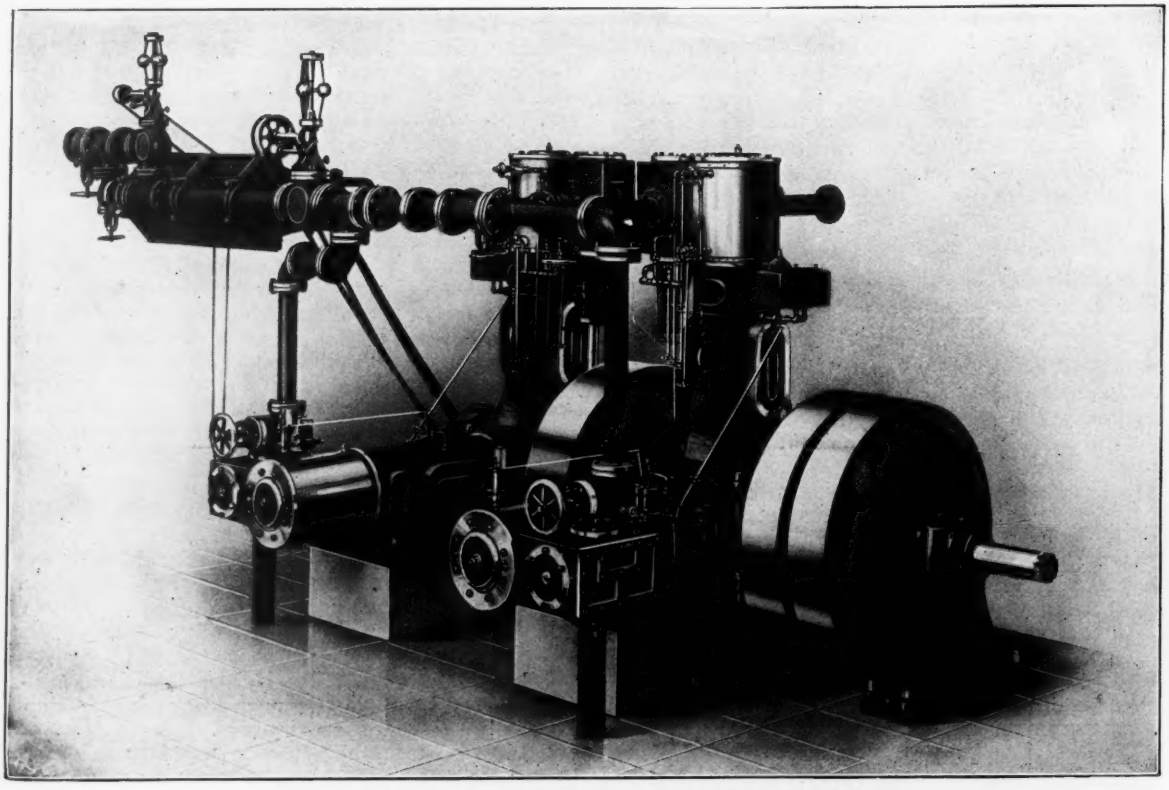


FIG. 1. THE AMERICAN-BALL 4-CYLINDER VARIABLE SPEED ENGINE

The American-Ball 4-cylinder paper mill engine is designed with 4 cylinders arranged in pairs at right angles. The engine is thus built of 2 units each of which has a vertical and horizontal cylinder. Each pair of vertical and horizontal strokes per revolution evenly distributed 45 degrees apart. A counterweight on each crank transfers the horizontal recipro-

continue around the whole circumference of the 2 wheels. The pins are set in the edges of the wheelrims in arcs of only 90 degrees, diametrically opposite. Therefore by simply removing the belt lacing and rotating either one of the wheels through an arc of 90 degrees, a section of the shaft may be lifted out without necessitating endwise motion of the shaft.

Speed Change Mechanism and Governors

FIGURES 1 and 3 show the speed changing and governing mechanism as used with these engines. The devices illustrated perform a number of important functions and, in fact, are a most important part of the whole engine equipment. Two governors are used, each of standard type, specially improved and adapted to this particular service. The first governor is the automatic engine safety stop and is placed nearest the steam supply pipe, being shown at the left in Fig. 3.

This governor is driven by belt directly from the engine shaft and is fitted with an automatic tripping mechanism. The steam valve remains wide open throughout the whole normal range of speeds for which the engine is designed, but in case the speed exceeds the predetermined limit the mechanism is tripped and the weighted lever closes the steam valve. At all normal speeds this governor valve has no throttling effect whatever, hence cannot affect the engine speed.

The second governor, which may be seen to the right in Fig. 3, controls the engine speed and is driven through the variable speed friction device also shown.

The requirements of constant speed throughout a wide variation in speed, as for paper mill service, is most difficult to meet. When once the speed of the engine has been adjusted to give a certain grade of paper, the speed must stay constant, and must not be affected by variations in steam pressure or back-pressure. To prevent such speed surges, a standard governor has been equipped with a mechanism comprising stabilizing springs and an oil pot, which may be seen in the photograph. The piston of the oil pot receives motion from the governor stem, through the spring stabilizing device, which absorbes shocks induced by sudden changes in speed of the governor balls.

This stabilized governor is driven from the engine through a variable speed friction device specially designed by The American Engine Co. A belt from a pulley on the engine shaft drives a pulley on the friction device, which drives a second pulley through

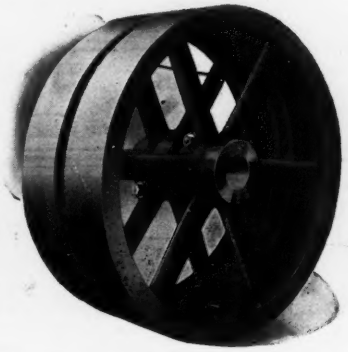


FIG. 2. PATENT FLEXIBLE COUPLING FOR PAPER MILL DRIVE

2 disks and 2 pairs of friction wheels. Any speed from minimum to maximum may be imparted to the second pulley, which in turn drives the governor.

Each of 2 large iron wheels is keyed to a pulley shaft. Bearing on the surface of these disks are 4 small friction wheels, one on each side of each disk. The driving disk keyed to the shaft of the driving pulley rotates the 2 friction wheels held against it by springs, and the second pair of friction wheels drives the second disk and the pulley keyed to its shafts.

The speed is changed by simply shifting the position of the friction wheels, which are carried by 4 rockers located in pairs, each pair being held to a shaft which passes through guides and may be shifted

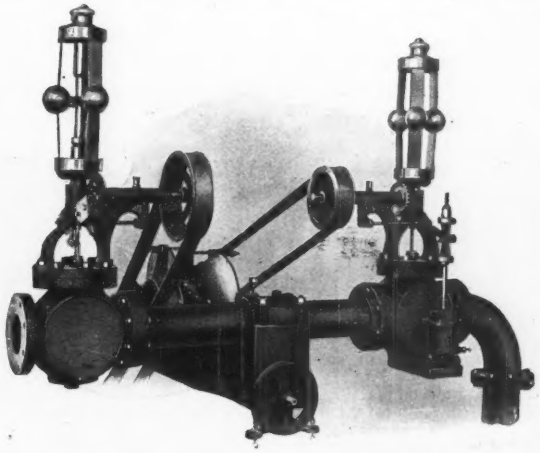


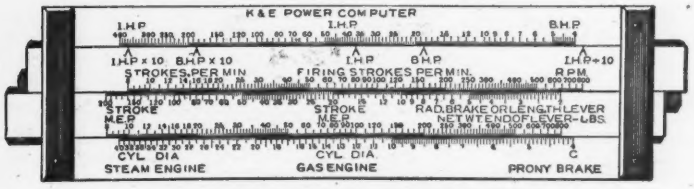
FIG. 3. SPEED CHANGE AND GOVERNING MECHANISM

as desired by a chain wheel and lead screw cut at one end. Each pair of rockers is held together by springs thus keeping the friction wheels firmly against the disk. All bearings are of the ball bearing type.

K. AND E. POWER COMPUTING SLIDE RULE

ILLUSTRATED herewith is a new computing device designed for quickly finding the power of engines either steam or gas, and of pony brakes, or from the power desired and several factors given, to find the other dimensions needed to produce the given power.

It applies to reciprocating engines of all types, and can be used not only for power calculations but for determining dimensions, and on the reverse side is a regular slide rule scale for making all sorts of computations.



K. & E. POWER COMPUTING SLIDE RULE

The rule is well constructed, with mahogany body, faced with white celluloid, upon which the graduations are placed. Rigid metal end pieces hold the different parts of the stock together, and adjustment is provided to insure smooth working of the slides.

The rule will be found a considerable time saver over ordinary slide rule computations by those who have frequent calculations of this sort to make. The rule is manufactured by the Keuffel & Esser Co., of Hoboken, N. J.

NEW TYPE OF METERS

SPACE economy is an essential factor these days when it comes to building a plant or laying out plans for additional machinery in an existing plant. Particularly is this true in the large cities where real estate values are high, but the advantages of saving space are always appreciated under any conditions. Any equipment, therefore, that effects this economy and at the same time, does not sacrifice any essential or advantageous features must necessarily win for itself a place in modern power plant construction.

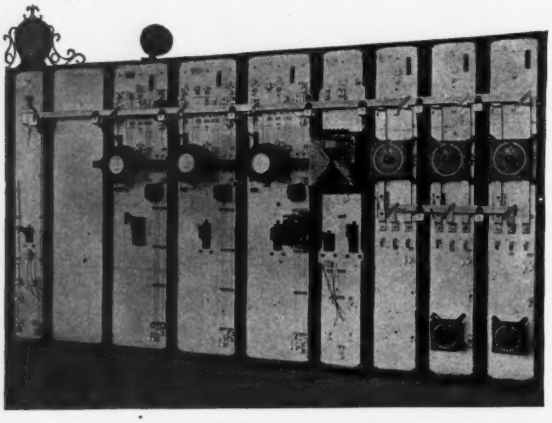


FIG. 2. REAR VIEW OF SWITCHBOARD AT MARE ISLAND NAVY YARD

No better example of this trend of modern construction has been afforded recently than by the line of Westinghouse 7-in. diameter switchboard indicating meters, which in the installation illustrated herewith effected a saving of 25 per cent in the floor space occupied by the switchboard. This switchboard illustrates a rapidly growing tendency on the part of designing engineers to economize in switchboard space by the use of meters occupying a minimum switchboard area, especially now that such meters can be obtained with a maximum scale length and readability.

This board is installed at Mare Island Navy Yard, San Francisco and consists of 19 panels of blue Vermont marble. All of the panels are either 16 or 24 in. wide—obviating the use of the larger panels usually found in a board of this size.

There are 63 meters included in the equipment, the 16-in. panels having 2 meters mounted thereon in a horizontal line, and the 24-in. panels have 3 meters mounted in a horizontal line—a form of construction that is quite desirable, and of course, entirely impossible with larger diameter meters.

The use of the smaller meters in this case meant a saving therefore of 7 ft. of floor space, 56 sq. ft. of marble, and much less ground to be covered by the attendant in operating the board.

The board controls 2 500-kw. and 1 1000-kw. 2300-volt, 3-phase, 60-cycle, generators with exciters. Provision is made for the future installation of a 2000-kw. generator. A voltage generator is mounted on panel containing the control apparatus for the induction motor driving one of the exciters.

A view (Fig. 2) of the rear of the board shows the neatness of the arrangement of wiring made possible by the use of remote control apparatus with consequent absence of heavy wiring, bus-bars and oil circuit breakers from the back of the board.

Another point of particular interest is the mounting of the watt-hour meters on the back of the board where they are accessible and at a convenient height to be read.

The board and instruments were supplied by the Westinghouse Electric & Mfg. Co.

A NOTABLE OVERLOAD BOILER TEST

IN a recent test of No. 12 boiler in the plant of the Narragansett Electric Lighting Co., Providence, R. I., produced for 8 hr. very nearly 250 per cent of rated boiler horsepower at an overall efficiency of boiler and grate of 73 per cent. This test was for the purpose of determining the capacity of a Riley self-dumping, underfeed stoker of 5 retorts, which had been placed under the boiler.

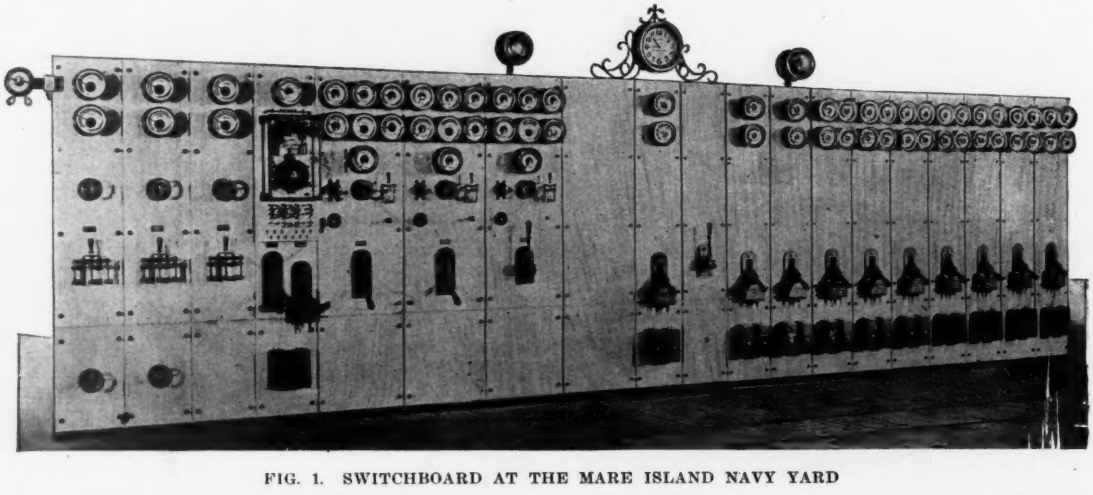
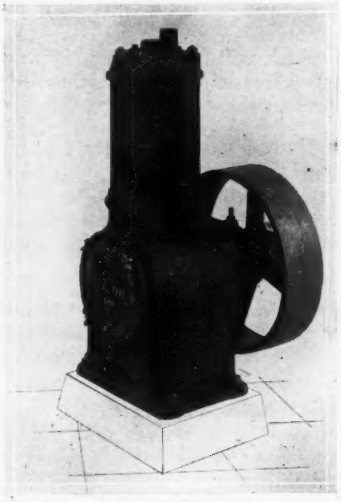


FIG. 1. SWITCHBOARD AT THE MARE ISLAND NAVY YARD

The boiler, which was 12 yr. old, is a B & W., 12 tubes high, 18 tubes wide, and 16 ft. long. No special effort was made to prepare it for this test. As a matter of fact, its companion boiler in the group of 2 was cold. The boiler was of such a size that a stoker of 7 retorts could have been installed under it, which would have resulted in the burning of more fuel and a considerable increase in the capacity obtained. As the stoker is of the self-dumping type,

working automatically, there was no periodic dumping, hence the steadiness of the steam pressure, 174.1 lb. average, and other operating conditions. The fire appeared to be in the same condition from one end of the test to the other, all clinker being broken up automatically during its process of formation, and the boiler was kept on the regular line for some hours after the test.

The total amount of coal consumed was 25,450 lb., or an average of 3181 lb. an hour. The water fed amounted to 251,170 lb., or an average of 31,396 lb. an hour, thus giving an evaporation of 9.87 lb. of water for each pound of coal. The water was fed at a temperature of 196 deg. F., and the equivalent water evaporated per hour from and at 212 deg. F. was 33,437 lb. an hour, or a total of 969.2 boiler horsepower developed, which was 248.5 per cent of builder's rating. The equivalent evaporation per pound of coal as fired thus figures out at 10.51 lb. of water, and the factor of evaporation is 1.065.



The coal analysis showed 74.13 per cent fixed carbon; 14.95 per cent volatile matter; 6.52 per cent ash, and 4.40 per cent moisture. The calorimeter test showed the heating value to be 14,600 B.t.u. when dry, or 13,957 B.t.u. as fired. The coal was thoroughly consumed as is shown by the flue gas analysis, which gave 16 per cent CO_2; 0.12 CO, and 2.7 per cent O.

At one time during the test a piece of 4 by 6-in. timber was purposely dropped into the center hopper to determine the effect upon the stoker. This timber, of course, blocked the plunger in that hopper and sheared the safety pin located on the connecting rod. The plunger was then automatically withdrawn from the stoker upon the return stroke of the connecting rod and left at its outermost position. Upon the removal of the obstruction and the insertion of the new pin, all of which was done without stopping the stoker, operation was resumed as if nothing had happened. Of course, however, the feed of coal into the middle retort was interrupted until the adjustment had been made. The horsepower used by the blower was determined as 20, while 1.4 horsepower was used to operate the stoker. Separate motors were used to drive blower and stoker.

AIR COMPRESSORS FOR SMALL PLANTS

DIVERSITY of profitable applications for compressed air in small volume around the average shop, foundry, factory and industrial plant has made the installation of a small air compressor an economical necessity.

In addition to the item of low first cost of installation, the use of compressed air by the small plant has made it necessary that the air compressor be economical in the use of power and maintenance and as nearly automatic in operation as it is possible to make any machine, so that the cost of attendance may not prove a burden to the purchaser.

Recognizing this demand, a line of small, vertical, air compressors, known as Imperial Type XII and possessing features of unusual merit, such as automatic lubrication, simple plate and ring valves, enclosed dust-proof construction and great compactness, etc., has recently been placed on the market by the Ingersoll-Rand Co., of New York.

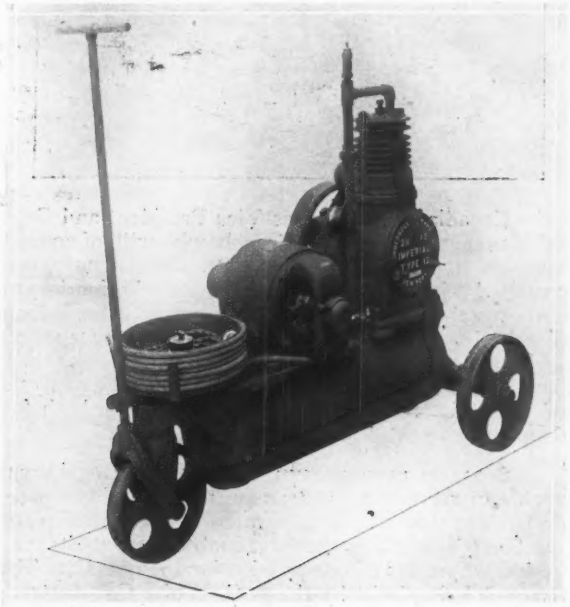


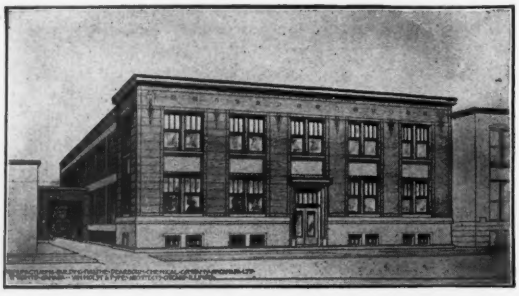
FIG. 1. IMPERIAL TYPE XII AIR COMPRESSOR FOR BELTING TO LINE SHAFT

These machines are furnished in a number of sizes, for belting to line shaft or as complete "electric drive" equipment; also as a portable machine in one size. They may be secured air cooled, water cooled or reservoir cooled (thermosyphon system) to meet local conditions. Capacities are from 4 to 23 cu. ft. and pressures up to 150 lb.

IN A RECENT INTERVIEW Leonard C. Wason, president of the Aberthaw Construction Co., gave a simple method of preventing condensation under a concrete roof of a power house in Boston, which now has a steam pipe under the roof to keep it warm. Mr. Wason stated that, of course, the thing to do is to insulate the roof and recommended taking off the gravel and putting down an insulating felt. As an alternative he recommended fastening sheets of cork to the under side of the ceiling, which would cost from 6 to 8 cents a sq. ft.

NEW POWER PLANTS

ON ACCOUNT OF THE RAPID development of the business of the Dearborn Chemical Co. in Canada, a Canadian Company has been organized to carry on the business there, and make further extensions. A manufacturing plant of reinforced concrete, shown in the accompanying illustration, is now in the process of erection at West Toronto, with shipping facilities on both the Canadian Pacific and the Grand Trunk Pacific railways. The building, which was designed by Von Holst and Fyfe, architects, Chicago, will be completed about midsummer. The investment that is being made by the Canadian company in building, ground and equipment will exceed $100,000. The active head



of the Canadian enterprise as Vice President and General Manager is Mr. A. W. Crouch, who will, of course, make his home at Toronto. Mr. Crouch has been connected with the Dearborn Chemical Co. for 15 yr., having established their Pittsburgh office, from which office he has been for the past 8 yr. district manager, in charge of a number of the company's branches. The Canadian company will specialize on the analysis and scientific treatment of boiler feedwaters, both for steam railroads and stationary steam plants.

A $100,000 DISTRIBUTING STATION, with equipment capable of receiving and transmitting the entire electric current that will be generated at the power plant now being erected on the Savannah River, at Stevens Creek is in process of construction in Augusta, Ga. The station is being built by the J. G. White Co., contractors, for the Augusta-Aiken Railway & Electric Corporation. It is expected that the plant will be completed within a year and will be ready to take care of the current from Stevens Creek when the big plant there begins operation.

The new building will be located on the canal bank on the site of the old West plant, which has been cleared away to make room for the improvement. The building will be fireproof, only brick, concrete and steel being used in its construction. Its dimensions are to be 58 by 39 ft., and the cost will be $20,000. The cost of equipment will be $80,000.

Current from this station will be distributed to the present power house of the corporation and to special consumers not only in Augusta, but in the territory around this city.

AT A MEETING of the Wayne County, Ind., commissioners with several members of the county council, the proposition of making an appropriation of $1800 for a new lighting system at the Wayne County Infirmary was discussed. It is proposed by the commissioners to install an electric lighting system at the institution to take the place of the system of kerosene lamp lighting now in vogue.

The committee from the county board of charities condemned the present system and recommended that a new one be installed. At the January session of the commissioners the proposition was favorably considered by the commissioners though the council refused to make the appropriation. The members of both bodies present conferred with Supt. Neuton Brumfield and decided favorably toward the action. At the next regular session of the council it will probably be decided to appropriate the money for the improvement.

KIMBALLTON, IOWA, HAS voted to bond the town for the purpose of putting in an electric light plant.

AT MISSION, TEXAS, contract has been given to persons owning teams to begin breaking ground for the water, electric and ice plant.

PLANS ARE BEING rapidly consummated in St. Petersburg, Fla., for the new power house which the St. Petersburg Investment Co. expects to erect.

IT IS UNDERSTOOD THAT Coshocton, Ohio, or some location in the immediate vicinity will be chosen by the United Service Co. for the site of the central power plant which will furnish electric power to Canal, Dover, New Philadelphia, Uhrichsville, Dennison, Cambridge and Coshocton.

WESTERN POWER CO. announces that upon completion this year of the Big Meadows dam, work will begin immediately on the construction of 4 additional power plants in California at a cost of $8,000,000. It is planned to develop a total of 675,000 hp., the installation to be completed in 1915.

WEST PENN, PA., powerhouse is to be doubled during the next 2 yr. Orders have been placed with the Westinghouse Co. for 2 big turbines of 24,000 hp. each. The company will spend $500,000 on the work.

Plans for increasing the size of the power house are now being drawn, it is stated, and the work will be started in time to be ready for the delivery of the first turbine late in this year.

The Kuhn interests are constructing a hydro-electric plant along the Cheat river and the fact that the power house is to be greatly enlarged leads to the belief that an invasion of West Virginia will follow the completion of the hydro-electric project and that much of the current generated at that plant will be used in the new territory.

WORK ON THE $7,000,000 power plant of the Great Northern railway on the Chelan River in Washington will soon begin, according to Robert Herzog, chief hydraulic and electrical engineer of the company.

The engineer's reports place the available horsepower when the dam is completed at 80,000 to 100,000. This will afford sufficient power for the electrification of the Great Northern main line east of the Cascades to the Idaho line and north on the Wenatchee-Pateros extension to Oroville, the northern terminus of the new line.

A force of 50 to 100 men will be put to work on the project at the start, and this number will be increased as the work progresses. It will probably take two years at least to complete the development plans of the transportation company, which has for its object the electrification of all its lines in eastern Washington.

The Oroville line, it is stated by officials of the Great Northern, will be operated by electricity from the start, scheduled for November. Materials and men are now being assembled at Chelan.

AT FULTON, N. Y., a contract has been awarded for building a power house at the Volney paper plant.

AT A SPECIAL ELECTION in Cedar Falls, Iowa, the voters decided to bond the city for $50,000 with which to build an electric light plant.

AN ELECTRIC LIGHT PLANT is to be erected at Gainsville, Fla. The waterworks extension, it is stated, will be taken up first, but work on the light plant will start as soon as material can be placed on the site.

LA MOURE, N. D., HAS GRANTED a franchise for a 125-hp. electric light plant, which is to be in operation within 6 months.

A lighting plant will also be erected for Lisbon, N. D.

KIMBALL, S. D. IS NOW sure of getting a $10,000 electric light plant installed. The franchise has been arranged by the city council and Kimball will soon have one of the best electric light plants in that part of the state, modern and up-to-date in every particular. The company expects to lease some railroad ground near the Milwaukee depot and will soon erect the building for the enterprise.

THE CORNING, N. Y. Light & Power Co., has been incorporated at Albany with a capital stock of $500,000. The directors are Daniel J. Creem, Clinton L. Rossiter and John McNamee, all of Brooklyn. Mr. Creem was the president of the Corning Gas & Electric Co., all of whose affairs will be taken over by the new company. The reorganized company will erect a large power plant in Corning, this summer, capable of handling a greatly increased business which is in prospect both in Corning and Painted Post.

THAT THE GENERAL ELECTRIC Co. plans to expend $1,000,000 and employ 10,000 at its Pittsfield, N. Y. plant within the next 2 yr. was divulged at a meeting of the board of aldermen, when petitions were presented for railroad tracks across Dalton Ave., and from E. D. Jones Co., and the Pittsfield Coal Gas Co. Hearings were held on the petitions, the committee reported favorably and something over 5000 hands are now at the plant. It is planned to erect 2 enormous buildings on land recently purchased.

AT DUNDEE FALLS, MAINE, on the Presumpscot River, a new power station for the S. D. Warren Co., paper manufacturers, is being erected under the general supervision of the Stone & Webster Engineering Corps. The dam structure, about 1400 ft. long, is of earth with the powerhouse and spillway of reinforced concrete, about in the center. The head to be utilized is 50 ft., with a wheel capacity of 4500 hp. The concrete spillway is of the gravity suction type. Power will be supplied by 3 33-in. horizontal turbines of the S. Morgan Smith type, each capable of developing 1500 hp. at 277 r.p.m. They are of the wicket gate type, the gates of each wheel being controlled by a Lombard governor. Each wheel is direct-connected to an 800-kw. General Electric generator operating 3-phase at 60 cycles a second, and at a pressure of 11,000 v. In each case the exciter is on an extension of the generator shaft.

THE CLAYTON PAPER CO. has started cleaning out the old Ax Factory Pond at Clayville, N. Y., preparatory to erecting a power plant on the site of the old ax shop. The tumble-down wooden dam will be removed and a concrete structure will be built in its place. From there a large concrete flume will be constructed to the power house, which will be located nearer the road. The size of the building has not as yet been decided upon, but it will doubtless be built with regard to future growth. A 5-ton, 24-in. turbine wheel will be installed. This will be connected to a 60-hp. generator. The power thus derived will be used to run the 3 large heating engines used in the manufacture of paper. The company cannot dispense with the use of steam entirely on account of the large amount needed in drying the paper; but by running the heavy heaters with electricity it will materially decrease the amount of steam required, as it will do away with one large engine.

CATALOG NOTES

A CIRCULAR FROM Sarco Engineering Co., 116 Broad St., New York, illustrates the Sarco water temperature regulator and explains its operation.

THE PLAYFORD improved chain grate stoker is illustrated as applied to various boilers, in a catalog recently received. The manufacturers are the Rosedale Foundry and Machine Co., Allegheny, Pa.

THE GENERAL ELECTRIC CO. has just issued Bulletin No. A4073, which deals with the electric equipment of bakeries. This bulletin refers to the sanitary advantages of such an equipment, the efficiency, economy of space, convenience, cost, maintenance and reliability, and illustrates the various pieces of apparatus used in bakeries, equipped with electric motors. It refers also to the electric lighting and to electrically heated ovens for baker's use.

THE DEPARTMENT OF COMMERCE has submitted to the Senate a list of the commercial organizations in the United States. This record, with a list of agricultural organizations, will be printed for distribution, provision being made for 1500 copies for the use of the Senate, in addition to which the list will be issued as a bulletin of the Bureau of Foreign and Domestic Commerce (Miscellaneous Series No. 8). Copies of this bulletin will be sold for 15 cents a copy by the Superintendent of Documents, Government Printing Office, Washington, D. C.

"REMEDY FOR WATER IN Compressed Air" is the title of Engineering Leaflet No. 14, issued by the Harrison Safety Boiler Works, 3144 N. 17th St., Philadelphia, Pa. It is pointed out that the presence of water in compressed air results in freezing and interference with the operation of tools, and that in some cases the presence of oil, introduced by the lubrication of the air compressor cylinder, causes disastrous explosions of compressed air receiving tanks. The suggestion of this leaflet is that Cochrane separators be installed in the air line to intercept the moisture.

THE INGERSOLL-RAND CO., 11 Broadway, New York City, has just issued a 40-page, 6 by 9-in. catalog, form 3008, covering its Class "PE" Duplex direct-connected electrically driven air compressors. Among the principal features of design and construction are: the clearance controller; the hurricane inlet valve; auxiliary water separator; enclosed flood lubrication for main bearings, crankpins and crossheads; liberal wearing surfaces; maximum port and valve areas. Catalog is illustrated and shows a table of sizes and capacities.

Form 575, issued by the same company, is a 28-page book of instructions for installing and operating Class PE direct-connected electric-driven air compressors, together with a duplicate part list.

TECHNICAL USES OF CHLORIDE of calcium are described in a booklet recently issued by the Carbondale Calcium Co., Carbondale, Pa.

AMERICAN SPIRAL PIPE Works, Box 485, Chicago, Ill., has recently issued leaflets illustrating various kinds and installations of pipe.

BULLETIN No. 73 on indicating and recording thermometers has just been received from the Industrial Instrument Co., Foxboro, Mass.

McCORD MANUFACTURING CO., of Detroit, Mich., is sending out a circular on McCord force-feed lubricators and McKim gaskets.

BULLETIN NO. A4066, recently issued by the General Electric Co., illustrates that company's electric hardening furnace. This publication supersedes a previous publication on this subject.

MONASH-YOUNKER CO., of New York and Chicago, has recently issued a pamphlet describing and illustrating the Monash noiseless system of vacuum heating.

BOGART AND CO., of Buffalo, N. Y., has issued a folder describing and illustrating internal combustion engines operating on manufactured, natural and producer gas, gasoline, kerosene, distillate and oils.

A FOLDER FROM John T. Lindstrom's Machine Works. 214-216 S. 3rd St., Allentown, Pa., shows the construction and operation of the company's improved steam separators and Corliss valve steam traps.

EVOLUTION OF THE COCHRANE Multiport Valve is the title of a booklet, telling the story of the logical method of invention by selection and elimination as applied to the development of this back-pressure and relief valve, issued by the Harrison Safety Boiler Works, Philadelphia, Pa.

ENGINEERS', MILL and railroad supplies are described and illustrated in Catalog S, from Advance Packing & Supply Co., Chicago, Ill. The catalog contains 1030 pages, including 16 pages of general information useful to engineers.

A SWAMP FILL forms the cover design of a pamphlet telling how a centrifugal pump was used in making a quick and inexpensive swamp fill. Various types of pumps are illustrated in the pamphlet, which is issued by the Goulds Manufacturing Co., Seneca Falls, N. Y.

NATIONAL TUBE CO. Bulletin No. 12, relative to the characteristics of National steel pipe, presents in small compass much information about pipe. Copies may be obtained by addressing the company at Pittsburgh, Pa.

TRADE NOTES

LEROY GORDON has been appointed manager of the New York office of the Nelson Valve Co. and Yarnall Waring Co., Room 301, 30 Church St.

IRVING N. BEELER has been appointed district sales manager for Central New York for Nelson Valve Co. & Yarnall-Waring Co., with office at 218 Bastable Bldg., Syracuse, N. Y

OHIO BRASS CO., of Mansfield, reports that although its factory was visited by the recent flood, all damage has been repaired and the works are operating at full capacity, and prompt service can be given both in manufacture and delivery.

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SEMI-MONTHLY
PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH

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Positions Wanted

POSITION WANTED—Electrical Engineer wants to locate with some reliable isolated plant in Public Service plant, nine years' experience at estimating, constructing and mining plants. Can give best of references as to ability and habits. Chas. Thomas, Jr., Box 464, Aurora, Ind. 5-1-1

EMPLOYER AND EMPLOYEE at that critical moment when each needs the other find Efficient Service Co., 1340 Monadnock Bldg., Chicago, Ill., "Efficient." R. E. Plumbe, Pres. Write for evidence tf.

POSITION WANTED—As engineer or switch-board operator in large station. Have eight years experience in power station. with high and low speed engines. Direct and alternating current generators. Prefer middle or western states. Address Box 293, Practical Engineer, Chicago, Ill. 4-15-1

POSITION WANTED—By first class gas engineer. A. and D. Current. Can give results and best reference. Sober and steady. Third year present plant. Address Box 296 Practical Engineer, Chicago, Ill.

POSITION WANTED—As chief engineer, age 31; married, understands electric machine, mechanical drawing, first class Ohio license; can give reference. Wages depend on the cost of living at that place. Address, Box 292, Practical Engineer.

Wanted

WANTED—SECOND HAND open type exhaust water heater, H. P. 110 to 150, give name, condition, style and price. Engineer, H. Roth Brewery, Monongahela, Pa. 5-1-1

WANTED—AGENTS TO SELL on commission Mechanical Draft Blowers. Prefer men who handle on similar bases sales of grate bars, tube cleaners or other boiler accessories. Hustlers wanted. State experience and territory worked. Address Box 290 Practical Engineer, Chicago, Ill. tf.

AMERICAN SERVICE CO., Pittsburgh Pa., require records of engineers, superintendents and production clerks for executive and shop vacancies. 5-1-2

WANTED—ALL STEAM USERS to have clean boilers without using compounds or chemicals in any form. Write "Otis," No. 317 Norfolk Ave., Buffalo, N. Y. tf.

WANTED—MECHANICAL ENGINEER Salesmen to take charge of branch offices in St. Louis, Chicago, Cleveland and Philadelphia, to push equipment used in connection with power plants. We have a good proposition to make to the right men. Address Geo. S. Crittenden, 201 Devonshire Street, Boston, Mass. 5-1-1

IF YOU ARE a night engineer, spend a few hours each day taking subscriptions for Practical Engineer. You will be paid well. Write Subscription Dept. They will start you in at once.

WANTED EVERY ENGINEER to have our pamphlet for setting valves on Corliss Engines, simple and compound, with one or two eccentrics. Sent free. Lindstrom's Machine Works, 200 South Third St., Allentown, Pa. tf.

Help Wanted

RESIDENT SALES MANAGER to sell Tidman's Reinforced Hollow Concrete Poles and State Rights. Calling only on steam and electric railways, telegraph, telephone, gas and power lines; states, counties and cities for ornamental purposes. No competition. Endorsements of highest class engineers. No experience needed. To result getter, income very large. Permanent future. State what territory and submit references. 941 Monadnock Bldg., San Francisco. 5-1-2

WANTED—EXPERIENCED MECHANICAL DRAFTSMAN for designing all manner of power pumps, etc. Steady employment. State age and salary. A. Y. McDonald Mfg. Co., Dubuque, Ia. 4-15-2

EDITORIAL POSITION—GOOD PAY to start. Position permanent with advancement. Experience with electrical machinery and knowledge of plant operation essential. Address Box 297, care of Practical Engineer, Chicago, Ill. 5-1-1

WANTED—An additional subscription solicitor wanted to cover towns in state of Washington. Excellent chance to earn extra money. Write to Subscription Department. tf.

For Sale

GENERATORS FOR SALE—2 Ft. Wayne Electric Works, Wal, 75-kw., 600 r.p.m., 2200-volt, 60-cycle, single-phase belted generators, with exciters, in good condition. Will make low cash price; one or both if taken promptly. Electrical Department, The Hanna-Brackenridge Co., Fort Wayne, Ind. 5-1-1

FOR SALE—14x32 Watts Campbell Corliss engine, seen running until May 1st condition like new, $600. Duzets & Son, 40 Church St., New York. tf.

Patents and Patent Attorneys

FIND OUT FOR YOURSELF what to invent and how to procure and sell a patent for the same. My book, "Inventor's Universal Educator," covers the matter from A to Z. 140 pages, elegantly bound. Also contains 600 mechanical movements and 50 perpetual motions. Price $1.00, postage free. Money returned if not more than satisfactory. F. G. Dieterich, 618 Ouray Bldg., Washington, D. C. 5-1-1

LAWRENCE J. GALLAGHER, formerly assistant examiner United States Patent Office; solicitor of patents. 2 Rector St., New York. 4-1-4

THE PATENTOME is interesting and instructive. A liberal education in patents and how to get them. Free on request. Established 1865. Anderson and Son, Patent Solicitors, 710 G St., Washington, D. C. 3-1-2

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PATENTABLE IDEAS WANTED—Send for 3 free books, R. B. Owens, 28 Owens Bldg., Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established, 1883. I make a free examination and report if a patent can be had and the exact cost. Send for full information. tf.

"PATENT PROFIT from Patton Service," is the title of our instructive booklet for inventors; sent free upon request Strong patents that legally protect are our specialty. Send sketch or model today. Harry Patton Co., 330 McGill Bldg., Washington, D. C. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Building, Washington, D. C. tf.

Educational and Instruction

ENGINEERS' POCKET MANUAL, 175 pages, edited by University of Tennessee, will be mailed every subscriber sending in one new subscription to Practical Engineer. Gild edges, bound in leather. tf.

Miscellaneous

IF YOU ARE an operating engineer, we know the Fetta Hot Process Water purifier will interest you. We would be glad to have your request for further information. Address the Fetta Water Softener Co., Richmond, Ind. tf.

ENGINEERS—DO YOU WANT to utilize your exhaust steam for heating or drying purposes, without back pressure on your engine? If so, address Monash-Younker Co., 1413 W. Jackson Blvd., Chicago, Ill. tf.

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Sparks From The Advertising Pages

Down in the hills of South Carolina live men and women who eat sticky yellow clay. *Tradition tells them it has food value.*

Go into Chinatown, San Francisco, on any day, and you will find Chinese burning sticks of punk before their Joss. *Tradition teaches them that this action will drive the evil spirits away.*

On their little island, north of Japan, the Ainu women tattoo the form of a mustache on their upper lip. *Tradition has decreed this disfigurement to be the essential part of beauty.*

Tradition influences our every action and thought. The delivery of opinions, doctrines, practices, rites and customs from ancestors to posterity affects the complex workings of the human brain against progress. It is our nature to depreciate any improvement or advancement which does not come to us by the Road of Custom. The New and the Original generate Antagonism and Skepticism.

Fulton and his first steamboat were booed and ridiculed; Morse and his telegraph met with opposition from the public and scientist. Many of our grandmothers and grandfathers refused for years to ride on railroad trains. They claimed it was an impossibility to travel at a speed of thirty miles an hour and draw breath.

The Antidote for Tradition is Advertising. It neutralizes the acids of opposition and removes the cobwebs of prejudice. And, *now* is the era of Advertising.

Publicity greets us in the breakfast newspaper, the morning car, the daily mail and the evening magazine. It has educated us to rapid progress. Improvements which would have seemed supernatural to our forefathers are accepted without wonder. The submarine, wireless telegraph and 80-mile-an-hour train did not bring an "Oh!" or an "Ah!" from our lips.

Naturally, Tradition is now confined to lines of thought or subjects not fortified by advertising. For instance, the medical profession has steadfastly refused to advertise, and as a result it is still burdened with the suspicion of the public.

Compare the effect of the recent announcement of Dr. Friedman's Tuberculosis Cure and Thomas A. Edison's Talking Moving Pictures. The former has been suspiciously ridiculed by press, public and even the medical profession, so that it will take years of cures to assure its universal use. The latter started a scramble of theatrical managers after first territorial rights. And, yet, it is much more logical to expect a cure for a bodily ill than a synchronic reproduction of the actions and syllables of life by machinery. *But—machinery advertisements have paved the way for a prompt adaptation of new inventions.*

Advertising prepares the way for improvement. And for this reason, it is well that you read the advertising pages in every issue of Practical Engineer. Here, the leading manufacturers of power plant equipment come to you, twice-a-month, to talk to you about their products. Even if your power plant is complete and if you are not in the market for a single article, the reading of the advertisements will keep you in touch with the trend of invention. It will remove the Tradition dust of bias from your mind.

And, when you do need a machine or an appliance, you can go about its purchase with the confidence that your knowledge has progressed with the improvements in the power plant field.